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BY V. WALTER GILBERT, D.D.S.

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NOTES

ON

DENTAL PORCELAIN

A PRACTICAL TREATISE ESPECIALLY
DEVOTED TO THE INTERESTS
OF THE BEGINNER.

BY

V. WALTER GILBERT, D.D.S.

OVER ONE HUNDRED PRACTICAL ILLUSTRATIONS.

SECOND EDITION.

PHILADELPHIA:
THE S. S. WHITE DENTAL MANUFACTURING CO.
LONDON:
CLAUDIUS ASH & SONS, LIMITED.
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IN LOVING MEMORY

OF

MY DEAR FRIEND AND BELOVED PRECEPTOR

Dr. Eli T. Starr

THIS BOOK

IS AFFECTIONATELY DEDICATED

BY

THE AUTHOR

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INTRODUCTION

Notwithstanding the fact that literature upon the subject of porcelain work has been much in evidence, there has appeared little information which is of value to the beginner in this class of work.

A student or practitioner desiring to make a start in the practice of porcelain work is wafted about by the opinions of others like a voter who listens to political "spellbinders." The opinion of the high-fusing enthusiast is accepted only to be discarded upon reading or hearing the opinion of the low-fusing enthusiast and *vice versa*. The wonderful assurance with which the different manufacturers make use of the word "best" is calculated to mystify the inexperienced. In the following pages the author has endeavored to describe the uses of the different grades of porcelain and to explain the principles underlying their application.

The many porcelain compounds now found on the market cover a wide range of adaptability. The characteristic working qualities, the difference in glazing point, the capability to withstand practical

manipulation, and the character of each compound when viewed in the finished work make it important that a study of these essentials should precede practical application.

An effort has been made in this volume to present the subject in a manner which will be fully understood by the novice as well as by the practitioner who is more or less familiar with this branch of dental practice. A study of porcelain as outlined in the chapter on "Laboratory Experiments" will aid in clearing up many things which are not fully understood by the general practitioner.

Many of the little things heretofore omitted because of their seeming unimportance have been included because as a matter of fact these little things are of vital importance, especially to the beginner.

Many of the illustrations are original and were made for this book. These original illustrations together with those made possible through the courtesy of The S. S. White Dental Mfg. Co., The Turner Brass Co., The Ransom & Randolph Co., Klewe & Co., and Mr. H. J. Caulkins will aid to a great extent in an understanding of the text.

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CHAPTER I

PORCELAIN—ITS PLACE IN DENTISTRY

A quick and an effective way of ascertaining the relation and value of any article to a given subject is to imagine the conditions which would exist if that article was no longer obtainable.

Imagine the condition of dentistry, were all the artificial teeth, porcelain bodies, gum enamels, etc., destroyed and no longer obtainable. Think it over and you will be pretty thoroughly convinced that no value can be placed upon the opinion of those who say "Porcelain has no place in dentistry."

Ever since artistic dental prosthesis became a possibility, porcelain has held an important place in the profession; in fact, dental prosthesis is today impossible if we do not make use of porcelain. No one will deny the fact that porcelain is the best material with which to construct artificial teeth. By reason of their physical resemblance to the natural teeth, and their other essential qualifications of strength, resistance to oral secretions, etc., porcelain teeth are used in constructing the artificial dentures of civilized humanity. If the "ready-made" artificial porcelain tooth was the only thing made possible by this material, the profession would have much for which to be grateful, but with porcelain other dental desiderata are made possible.

Porcelain Dentures The modern continuous-gum denture, when properly constructed with a porcelain compound specially made for the purpose, cannot be equalled in point of cleanliness and natural appearance. Porcelain of itself is clean, it presents a surface which is smooth and if glazed is impervious to moisture, it is to a large extent translucent, and capable of being pigmented to reproduce the appearance of living tissue. A denture made entirely of porcelain like the Dunn Mineral Plate, or a denture made by firing porcelain upon a platinum base like the modern continuous-gum plate, comes nearer to restoring natural conditions than can a denture made of any other material. As a material for constructing artificial dentures, porcelain possesses some disadvantages, *i. e.,* there is some danger of breakage (out of the mouth), it requires skill to employ it, and it is expensive; but these disadvantages, not one of which is too serious to be overcome, are more than offset by the enumerated advantages.

The first disadvantage, danger of breaking a porcelain denture, will be reduced to a minimum if the patient will take the precaution to place a towel or wash-rag in the basin or receptacle over which the denture is being cleansed. The second so-called disadvantage, requirement of skill on the part of the dentist, can hardly be allowed if the dentist will provide himself with the proper outfit and then devote some time to the practice of manipulating porcelain. Skill on the part of the student and dentist is required for the proper manipulation of porcelain, but lack of skill in the dentist should not be counted as a serious disadvantage of porcelain itself.

The third so-called disadvantage, that of expense, is not so much real as it is imaginary. The items of

time and platinum constitute the elements of expense in the "make-up" of a porcelain denture. Both of these items cost more than the time and materials required for the construction of a gold or rubber denture, it is true; but compare the results, and you will find the porcelain denture cheap in comparison.

"All works of taste must bear a price in proportion to the skill, taste, time, expense, and risk attending their invention and manufacture. Those things called dear are, when justly estimated, the cheapest; they are attended with much less profit to the artist than those which everybody calls cheap. Beautiful forms and compositions are not made by chance, nor can they ever in any material be made at small expense. A competition for cheapness, and not for excellence of workmanship, is the most frequent and certain cause of the rapid decay and entire destruction of arts and manufactures."

If the dentist will take the necessary time and care to explain to his patients the superiority of a porcelain denture over the ordinary denture of vulcanite, he will find less objection to expense than he anticipates.

Quality is always appreciated by an intelligent public, and the world is full of people who want the best that skill and brains can produce. Perhaps the greatest field for the application of porcelain in dentistry is in the construction of individual crowns. Now that the supply houses furnish ready-made compounds of porcelain in a variety of texture, color, and firing point, and that firing facilities have been so improved as to permit the control of temperature, porcelain crown work has been placed on a practical basis.

Porcelain Crowns From an esthetic and hygienic view-point, porcelain is the ideal material for restoring the lost crowns of the natural teeth. Were it not for the third essential qualification—that of strength—it might safely be claimed that porcelain could be used universally for the construction of crowns.

By reason of their prominent location in the mouth, the six anterior teeth and the bicuspids should be restored with porcelain whenever practical conditions will permit.

Ready-made crowns, such as the "Logan" and "Davis," are now obtainable in such a variety of form and shade as to indicate their use either as they are purchased or as a base to be treated to meet special requirements. The translucent characteristic of porcelain indicates its use in "backing" artificial facings so that the rays of light may pass through the finished crown and thus do away with the "yellow tint" made by a gold backing and the "gray tint" made by a platinum backing. The hygienic properties of a crown are greatly increased by the use of porcelain; there is no metallic taste, no joint to be forced open, thus forming a lodging place for organic matter; no galvanic action can take place between a porcelain-backed facing and the crown or filling of an occluding tooth.

Because the essential feature of strength has been referred to as qualifying the universal application of porcelain to crown construction, it is not to be inferred that porcelain does not possess sufficient strength to permit of its use in constructing artificial crowns. Where a sufficient quantity of porcelain can be placed back of a "facing" or below a band, the resultant crown will be stronger than a similar crown backed with a metal.

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From the above statement it will be understood that the use of this material in crown work has a wide range of application, but it is highly essential to remember that it has its limitations, and these limitations must be respected. In all cases requiring artificial crowns, where the occlusion is such as to permit only a thin backing or cusp, porcelain is contraindicated.

Great importance is to be attached to the fact that the esthetic and hygienic qualities, so important to crown work, are possessed by porcelain, and it should be understood that when strength can be had in conjunction with these essential qualities the ideal crown can be constructed, but do not lose sight of the fact that without the essential quality of strength the other qualities are valueless. Discriminating judgment plays a very important rôle in porcelain work of all kinds, and it is because of the lack of this judgment that we witness failures and hear extravagant assertions relative to this material.

Any material which approaches the ideal to the extent which porcelain does is likely to be overestimated by enthusiastic experimenters, and so it is not strange that we hear some men claim that "porcelain is universally applicable and is destined to supplant gold."

Elbert Hubbard says: "The man who follows physical culture as a business is as big a fool as the man who flouts physical culture entirely." The essence of this assertion applies with equal force to dentists who look upon porcelain as a panacea.

So it is extremely important that the student guard against making an indiscriminate use of this important material and to apply it in its proper place.

Porcelain Fillings As a filling or inlaying material for restoring the lost parts of the natural crowns, porcelain has a good field of application.

The necessary appliances, porcelains, etc., have been so perfected that this work can be accomplished without any of the disagreeable features which confronted the pioneers in the use of this material. It is practical to make porcelain inlays, they are durable when properly made and located, and the material should certainly be given a place in the practice of every dentist who cares anything about the esthetic side of his calling. As in crown work, discriminating judgment must be exercised regarding the application of this material—even to a greater extent than in crown work, for the strength of an inlay often depends not alone upon its bulk, but upon its form and position in relation to the antagonizing teeth.

CHAPTER II

DENTAL PORCELAINS

Before purchasing an outfit and undertaking to make practical application of porcelain, it is highly important that the student familiarize himself with the fact that the various requirements of practice necessitate a variety of porcelains to fulfill those requirements.

Do not make an initial mistake by supposing that any one grade of porcelain may be regarded as a "cure-all" and that it possesses qualities which will meet all dental requirements. This supposition has been responsible for many failures in porcelain work. A porcelain compound which has been especially prepared to meet the requirements of a full artificial denture will not be entirely satisfactory for the production of a small inlay. A porcelain compound especially prepared to meet the requirements of a small inlay will not be entirely suitable for the production of a full artificial denture. The working qualifications and the tests to which the finished article must be subjected will be so varied as to require compounds having definite characteristics for definite classes of work, and this point must be borne in mind and freely accepted if the best results are desired.

Many of the older members of the profession, who in the years gone by used porcelain for the construction of artificial teeth, fail to understand why their modern successors desire different porce-

lain compounds for the production of crowns and inlays. Some of our present porcelain workers fail to understand why the old porcelain compounds are not suitable to meet present-day requirements. As a consequence of this failure to study the subject and use discriminating judgment regarding the uses to which porcelain is subjected, we hear many unjust criticisms and foolish statements which tend to confuse and prejudice the inexperienced.

In order to present the student with proper data for a preliminary study, porcelain compounds will be divided into three classes:

BLOCK BODIES—HIGH-FUSING PORCELAIN AND LOW-FUSING PORCELAIN

The Three Grades These three classes include compounds which have been especially prepared to meet specific requirements. An understanding of said requirements and the porcelain best adapted to fulfill them will prove of great value in deciding just what to purchase and use.

Block Bodies The term Block Bodies has been used to designate those compounds which were largely used by the profession before the advent of tooth manufacturers. They may be defined as porcelain compounds which vitrify or take the glaze at a temperature equal to or above the glazing point of American-made artificial teeth.

Compounds similar in nature to these so-called Block Bodies are now used by the manufacturers of artificial teeth and also by some practitioners of dentistry who prefer to carve and fire their own artificial

teeth rather than accept the factory-made teeth of the manufacturer. The compounds which are suitable for the carving of teeth are entirely different in character from the compounds which are now popular with the profession and which are being used in the construction of crowns and inlays.

The chief difference between the old-line porcelains and the porcelains of today is in the firing or glazing point. Other points of difference exist between the compounds, but they are not so marked as is the firing point.

It should be understood that Block Bodies were in vogue before the appearance of the electric furnaces and many of the gas and oil furnaces which we have at the present time.

Under the old firing conditions a dentist was obliged to use a furnace made of fire-clay, built in sections which were held together by iron bands. Coal was the source of heat, and by its use very high temperatures could be produced. It should also be remembered that block bodies were used before the manufacturers of artificial teeth provided the great variety of forms and shades which they now manufacture and carry in stock ready for selection and application by the dentist.

The advent of the modern artificial tooth is responsible for the discontinuance of old hand-carved methods of producing teeth, and as a natural consequence block bodies have largely been discarded. For the purposes intended these block bodies were essential to the desired results; a porcelain having a high firing point was as much a necessity in producing teeth by the hand-carved method as it is today in producing teeth by the molding methods of the modern tooth manufacturers.

The Use of Block Body To those members of the profession who are not satisfied with the artificial teeth produced in the factories of the manufacturers and to those who possess the knowledge and skill necessary to produce a better product in their own laboratories by their own hands, the so-called "block bodies" are recommended.

The employment of block bodies will require a furnace especially made for obtaining and maintaining very high temperature. Do not be deceived by any statements to the effect that the present type of electric furnaces can be depended upon to fire large cases made of block body. It is true that some of the bodies having an extremely high firing point can be glazed in the electric furnace; but this fact should be accepted only with the understanding that while this high temperature can be obtained and maintained for a short time, it is not practical to subject the platinum wire of an electric furnace to any such strain. The only furnaces which can be recommended for obtaining and maintaining practical temperatures for this class of work will be found described under the chapter on "Furnaces."

HIGH-FUSING PORCELAINS

The term "High-Fusing" is relative rather than definite, but it seems to have been accepted by the profession to mean a porcelain which vitrifies or takes the glaze at a temperature higher than the melting point of pure gold. Such a definition means nothing so far as composition or general characteristics of the porcelain is concerned. The words "High-Fusing" are simply relative as to the firing

point, and are used to distinguish this grade of porcelain from the "Low-Fusing" porcelains or those which vitrify or take the glaze at a temperature lower than the melting point of pure gold.

According to the definition given above, the extremely high-fusing porcelains, or those which have been described as block bodies, are included under the term high-fusing.

High-Fusing Porcelain In order to make the term a little more comprehensive to the student, the generally accepted definition of "High-Fusing" will be modified to read as follows: A porcelain which vitrifies or takes the glaze at a temperature somewhere between the melting point of pure gold and the glazing point of an American-made porcelain tooth. Under the latter definition can be classed most of the porcelain compounds which the profession is using for the construction of continuous-gum dentures, crowns, bridges, and inlays.

While there are many compounds of porcelain which are classified under the general term of "High-Fusing," it is important to remember that no two of these compounds are alike except in name.

Each manufacturer of dental porcelain has characterized his product by some peculiarity in formula or in method of preparation, so that while their various fusing points have placed most of them under the definition of the term "High-Fusing," their individual working and physical characteristics call for recognition as individual porcelains.

The best and in fact the only way for the student in porcelain work to become familiar with the characteristics of the different porcelains is to supply himself with a small quantity of each, and with them make the necessary laboratory or clinical experiments.

The Use of High-Fusing Porcelain For the construction of artificial crowns and inlays, porcelain compounds of the high-fusing variety are recommended, and if it is this class of porcelain work which the student desires to pursue, he will do well to purchase samples of this grade of porcelain and experiment until he finds the special compound best suited to meet his individual requirements.

LOW-FUSING PORCELAINS

Low-Fusing Porcelain This term is generally accepted to mean porcelain compounds which vitrify or take the glaze at a temperature below the melting point of pure gold.

This definition is subject to the same remarks as have been given in reference to the term High-Fusing; that is, while there are several compounds of porcelain classified under the term Low-Fusing, it is important to remember that no two of these compounds are alike except in name. In the effort to produce a porcelain whose firing temperature would be lower than the melting point of pure gold, each manufacturer has produced a material having peculiar characteristics, and these characteristics must be understood before a selection can intelligently be made.

For the construction of certain classes of inlays, the Low-Fusing porcelains may be employed, but their range of adaptability is to a great extent limited by the nature of their working qualities and the skill of the dentist.

The firing conditions at the disposal of the stu-

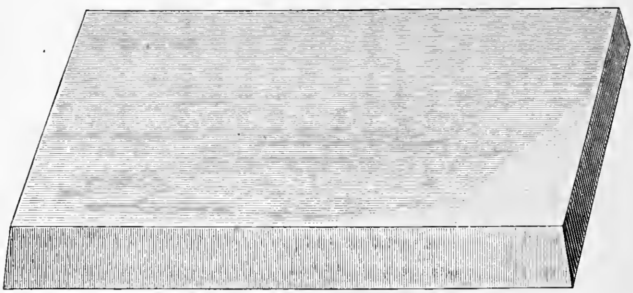
dent will, in a manner, influence many in their selection of a dental porcelain. In localities where the electric current is not obtainable, and the use of gasoline and fuel oil is prohibited, gas becomes the only means of firing porcelain. Under this condition there is little choice to be made, and, as a consequence, the Low-Fusing porcelains which will vitrify or take the glaze at a temperature obtainable by the ordinary gas blowpipe must be selected.

CHAPTER III

LABORATORY EXPERIMENTS

Certain laboratory experiments with the various porcelain compounds now available will prove of great value to either student or practitioner. If the characteristic working qualities, firing point, amount of shrinkage, strength, stability of color, etc., of the different porcelains are understood, it will be an easy matter to select that compound which meets individual requirements, and in this way much time, worry, and expense may be saved.

FIG. 1



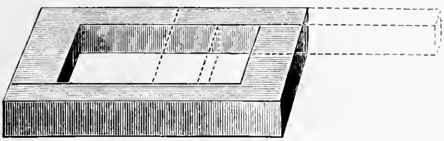
A simple yet an effective method of testing the qualities of a porcelain will be found in pursuing the following plan: Make an outfit consisting of an absorbing block and a small brass form. The absorbing block should be of plaster, and it can be easily made by mixing plaster rather thick and pouring the same into a discarded box-lid or anything which will give the block form and permit of a level surface. (Fig. 1.)

The brass form should be made in two parts, each part consisting of one end and one side. (Fig. 2.)

Fig. 2

Such a form will permit of adjustment and provide a means for making porcelain blocks of many sizes. (Fig. 3.) The plaster block is used for the

Fig. 3



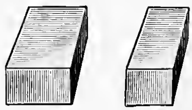
purpose of absorbing water from the mixed porcelain.

With this simple outfit and samples of porcelain it is possible to conduct a series of experiments which will show comparative qualities of firing point, shrinkage, color stability, and capabilities of contour. In order to place the different compounds under test on an equal basis, the little form should be marked so that all the blocks will be of uniform shape and size. Before using the form it and that portion of the plaster block on which the porcelain is to be poured or packed should be wiped clean and slightly oiled.

Place the oiled form on the absorbing block, mix the porcelain to the desired consistence on a clean glass slab, and then, holding the form in place with the

index finger and thumb of the left hand, pack or pour the porcelain into the form with a spatula held in the right hand. Allow the porcelain to set, level the surface with a knife or spatula, and with the index finger and thumb of both hands give the form and porcelain a downward and outward pressure, thus separating the porcelain block from the plaster, after which the parts of the form can be slid apart and the test piece laid aside, dried, and placed on a slide ready for the furnace. (Fig. 4.)

FIG. 4



Test for Shrinkage Shrinkage of any porcelain will, to some extent, be dependent upon the character of the mix. If the porcelain is mixed with water to a point similar to the consistence of thick cream, the fired piece will show a greater shrinkage than will a piece in which the mix was of a consistence similar to putty. In making comparative tests of the different porcelains, the above point must be observed, and each grade of material should be worked in a uniform manner.

Test for Glazing Point In testing the firing or glazing point of a porcelain compound, the student may wish to ascertain the time required by a given furnace, or he may wish to know how the firing point of one compound compares with the firing point of another.

In either case the little test pieces will prove of more value than will any temperature table purporting to give the firing points of different porcelains in degrees Fahrenheit.

Author's Experiment An experiment made by the author will give an excellent understanding of the differences in firing point between ten of the well-known porcelain compounds. There is no other way of intelligently designating these porcelains except by the name of the manufacturer, and as nothing of a prejudicial character will be said, there can be no objection on the part of those who prepare the porcelains.

TEST FOR RELATIVE FIRING POINT

The porcelains under test were as follows:

The Jenkins Porcelain Enamel.
C. Ash & Sons' Low-Fusing Porcelain.
C. Ash & Sons' High-Fusing Porcelain.
The S. S. White Co.'s Medium-Fusing Porcelain.
The Consolidated Co.'s High-Fusing Porcelain.
Brewster's Enamel Body.
Brewster's Foundation Body.
The S. S. White Co.'s High-Fusing Porcelain.
S. L. Close's Body.
Allen's Body (S. S. White Co.'s make).

In order to place each porcelain upon equal footing, a mold was constructed (Fig. 5) for the purpose of making test cones, and a second mold, such as shown in Fig. 6, was made for producing a slab of porcelain which would hold the test cones while they were being fired. By making these test cones all in the same mold, a uniform size and form was assured.

In the slab mold, ten forms were made from The S. S. White Co.'s High-Fusing Porcelain, and in the cone mold, ten cones from each of the porcelains

above designated. Upon each of the molded slabs a cone of each of the porcelains was set, care being taken to place them in the same relative order on all of the slabs. There were thus constructed ten test pieces, so arranged that comparison of results should

Fig. 5

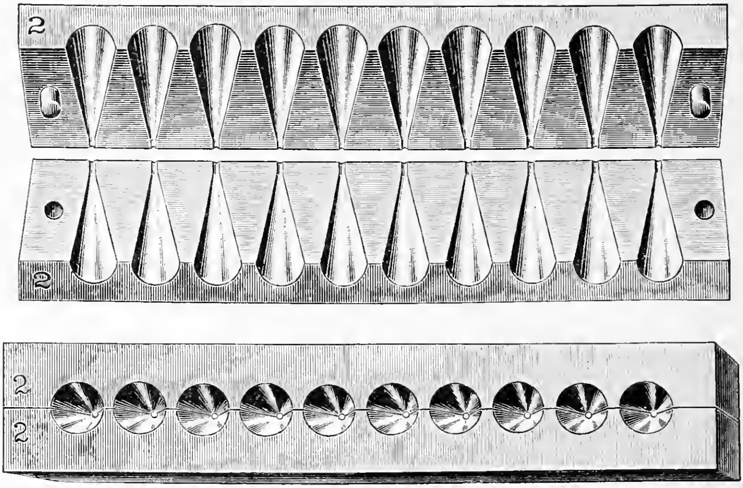
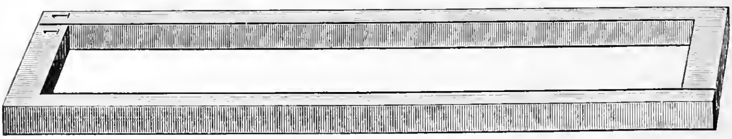


Fig. 6



be easy. These test pieces were then fired, one after the other, exposing all to the furnace heat under as nearly as possible the same conditions.

The first was removed from the muffle as soon as the characteristic glaze appeared on the material having the lowest firing point, the second, when the glaze appeared on the next higher-fusing porcelain; and so on through the entire lot. each

showing the firing point of one particular porcelain together with the effect of that temperature on all the others. At the end of the experiment we had a clear indication of the relative firing point of all the porcelains under test. The result of each test piece should be seen to be appreciated, for the test not only shows the relative firing point of each porcelain compound, but it gives an excellent idea of the amount of shrinkage in each grade of porcelain, and it shows conclusively the amount of abuse which each compound will stand, the capabilities of contour, and stability of color.

It is impossible to portray all these results upon paper, but the relative firing point of the ten porcelains can be shown by the following illustrations:

Fig. 7 illustrates the condition of the ten cones before they were placed in the furnace.

Fig. 7

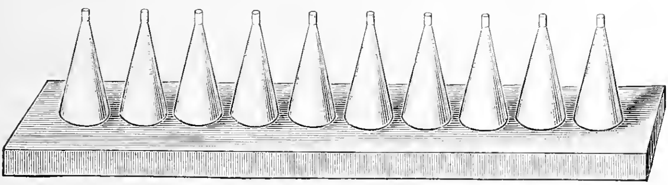
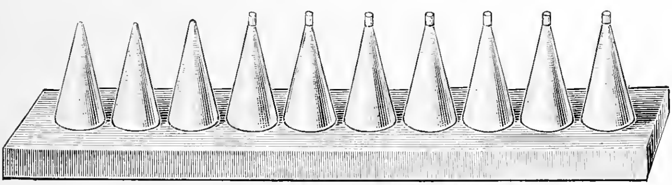


Fig. 8 illustrates the condition of the cones after

Fig. 8

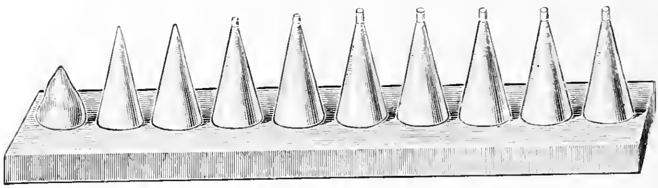


the porcelain having the lowest firing point (Jenkins's) took the glaze. The temperature necessary to

glaze the Jenkins porcelain did not glaze Ash's Low-Fusing Porcelain, although it caused some shrinkage in both Ash's Low and Ash's High. No appreciable effect was made upon any of the other seven porcelains.

Fig. 9 illustrates the condition of the cones after

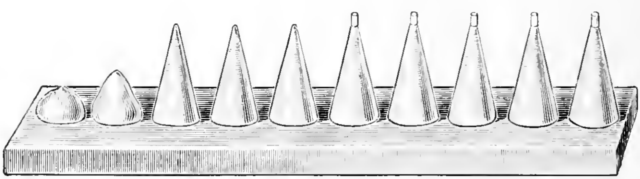
Fig. 9



the porcelain having the second higher firing point (Ash's Low-Fusing) took the glaze. The temperature necessary to glaze Ash's Low-Fusing Porcelain overfired Jenkins's to the extent shown, caused shrinkage of Ash's High-Fusing Porcelain, The S. S. White Co.'s Medium-Fusing, and the Consolidated Co.'s High-Fusing, but had little appreciable effect upon the Brewster Enamel, Brewster Foundation, S. S. White Co.'s High-Fusing, Close's Body, and Allen's Body.

Fig. 10 illustrates the condition of the cones after

Fig. 10

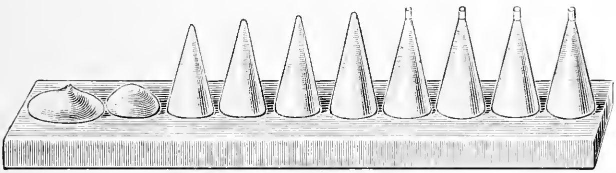


the porcelain having the third higher firing point (Ash's High-Fusing) took the glaze. This test shows that the temperature necessary to glaze Ash's High-

Fusing Porcelain overfires both the Jenkins and Ash's Low-Fusing to the extent shown, partially glazes The S. S. White Co.'s Medium-Fusing, Consolidated Co.'s High-Fusing, Brewster's Enamel, and effects the shrinkage of Brewster's Foundation, S. S. White Co.'s High-Fusing, Close's Body, and Allen's Body.

Fig. 11 illustrates the condition of the cones after

Fig. 11

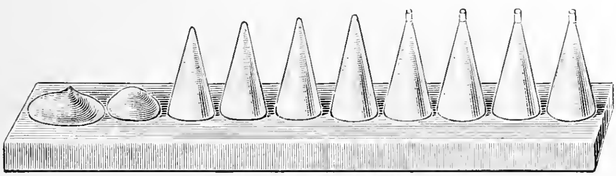


the porcelain having the fourth higher firing point (S. S. White Co.'s Medium-Fusing) took the glaze.

The temperature necessary to glaze The S. S. White Co.'s Medium-Fusing Porcelain overfires Jenkins's, Ash's Low-Fusing, and Ash's High-Fusing to the extent shown; it also increases the glaze of the Consolidated Co.'s High-Fusing, Brewster's Enamel, partially glazes Brewster's Foundation, The S. S. White Co.'s High-Fusing, Close's Body, and hard biscuits the Allen Body.

Fig. 12 illustrates the condition of the cones after

Fig. 12

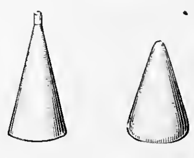


the porcelain having the fifth higher firing point (Consolidated Co.'s High-Fusing) took the glaze.

The temperature required to properly glaze this porcelain overfires Jenkins's, Ash's Low-Fusing, Ash's High-Fusing to the extent shown; very slightly overglazes The S. S. White Co.'s Medium-Fusing, about glazes Brewster's Enamel, and increases the glaze of Brewster's Foundation, The S. S. White Co.'s High-Fusing, the Close and Allen Bodies. (The S. S. White Co.'s Medium-Fusing and the Consolidated Co.'s High-Fusing have practically the same firing point.)

Since this experiment was made the Consolidated Dental Mfg. Co. have marketed a new product which has a glazing point considerably higher than the porcelain first made by them. The glazing point of their present grade of porcelain is higher than the glazing point of Allen's Body. The difference in glazing point between the Consolidated Company's High-Fusing Porcelain and Allen's Body is shown in Fig. 13. The temperature required to properly

Fig. 13

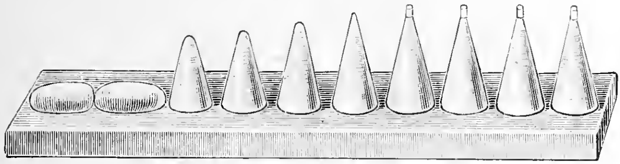


glaze the Consolidated Dental Mfg. Co.'s High-Fusing Porcelain overfires the Allen Body to the extent shown. The effect which this temperature would have upon the other nine porcelains will be left to the imagination.

Fig. 14 illustrates the condition of the cones after the porcelain having the sixth higher firing point (Brewster's Enamel) took the glaze. The tempera-

ture required to glaze Brewster's Enamel overfired Jenkins's, Ash's Low, Ash's High, S. S. White Co.'s

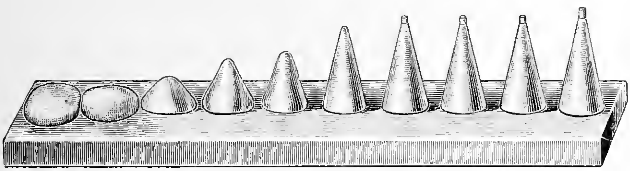
Fig. 14



Medium, and Consolidated Co.'s to the extent shown, and took practically all the shrinkage from the Brewster Foundation, S. S. White Co.'s High, Close, and Allen Bodies.

Fig. 15 illustrates the condition of the cones after the porcelain having the seventh higher firing point

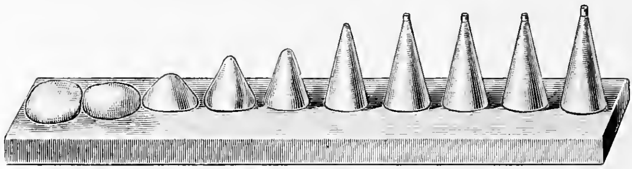
Fig. 15



(S. S. White Co.'s High-Fusing Porcelain) took the glaze. The temperature required to properly glaze this porcelain overfired the Jenkins, Ash's Low-Fusing, Ash's High-Fusing, S. S. White Co.'s Medium, Consolidated Co.'s High-Fusing, and Brewster's Enamel to the extent shown; closely approximated the proper glaze of the Brewster Foundation, the Close and Allen Bodies. (This test clearly demonstrated that the firing point of The S. S. White Co.'s High-Fusing Porcelain, Brewster's Foundation Porcelain, and Close's Body are approximately the same.)

Fig. 16 illustrates the condition of the cones after the porcelain having the eighth higher firing point (Brewster's Foundation) took the glaze. The temperature required to properly glaze the Brewster

Fig. 16



Foundation overfired the Jenkins, Ash's Low and Ash's High-Fusing, The S. S. White Co.'s Medium, The Consolidated Co.'s High-Fusing, Brewster's Enamel, and The S. S. White Co.'s High-Fusing to the extent shown. (This test again shows that the firing point of The S. S. White Co.'s High-Fusing Porcelain, Brewster's Foundation, and Close's Body are approximately the same.)

Fig. 17

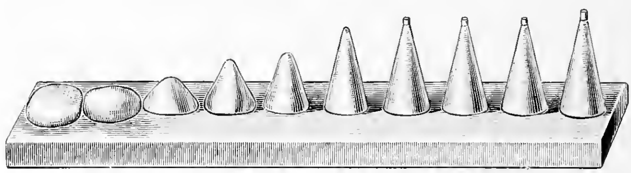
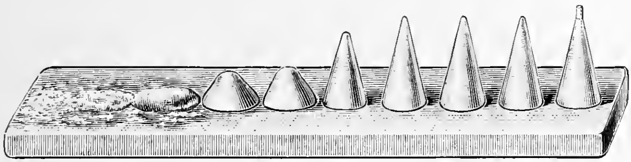


Fig. 17 illustrates the condition of the cones after the porcelain having the ninth higher firing point (Close's Body) took the glaze. (This test showed practically the same result as the two previous tests, and again proved that The S. S. White Co.'s High-Fusing Porcelain, Brewster's Foundation Porcelain, and Close's Body are practically alike as far as firing point is concerned.)

Fig. 18 illustrates the condition of the cones after the porcelain having the tenth higher firing point (Allen's Body) took the glaze. The temperature required to properly glaze Allen's Body overfires all the other porcelains to the extent shown.

Fig. 18



The practical relative firing point of these ten porcelains is clearly shown in the above tests, and the result gives the student a much better conception of the temperature required to glaze a given porcelain than can be gained from a table purporting to show the firing point of the different porcelains in degrees Fahrenheit.

Pyrometers, which are practical instruments for determining the definite temperatures at which a given porcelain compound takes a certain degree of glaze, can be depended upon to show the relative difference in the glazing point of the various porcelains; but no device showing this difference in cold type only can instruct the "worker" like the test detailed above.

Test for Contouring Qualities and Color Stability

For practical application in crown work and in many classes of inlay work it is essential that the porcelain be capable of maintaining a desired form during the firing process.

Well-defined cusps and sulci are a necessity in crown construction to restore the utilitarian needs of mastication, and well-defined lines of contour and

contact are a necessity in inlay construction for restoring the hygienic and esthetic requirements.

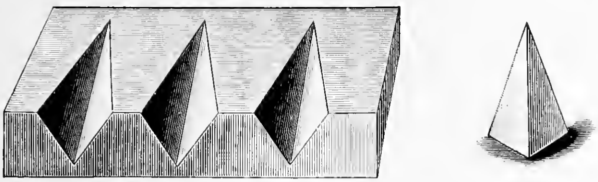
Stability of color is another essential quality of a dental porcelain, and it is desirable that this quality be present to a marked degree. There is a great difference exhibited by the various compounds when practically tested for either of the above qualities. Some of them must be treated with great care in the mixing and must be watched very closely while in the furnace, in order to insure contour and color; while others do not require such detailed care in the mixing, and they can be left in the furnace for a limited time beyond the actual time required to glaze them without any practical change occurring in either contour or color. This difference in practical working qualities is one which should be thoroughly understood by the student, for it has an important bearing upon all porcelain constructions.

Either of the tests for shrinkage or firing point, previously outlined, will afford a ready means of determining to what extent each compound of porcelain possesses the capabilities of maintaining contour and color; but another easy method is to cut a triangular groove in a piece of metal (Fig. 19), and in this groove pack a little of the mixed powder to be tested. This will produce a little triangular pyramid, having three well-defined lines running to a common point, and it will make a good test piece upon which to try the effect of temperatures.

The effect of heat upon these little test pieces will give an excellent idea of what may be expected in the practical firing of inlays and crowns. Some of the porcelain compounds require great care in the firing in order to make them hold their color and maintain the sharp lines and points; there is a ten-

dency to assume a spheroidal form when subjected to only a slight excess of temperature. Others require less care in the firing in order to produce the proper color and contour, and a considerable excess

Fig. 19



of temperature will be endured without any practical effect. To illustrate this point: When placed in the furnace a piece of porcelain has this form (Fig. 20); the slightest excess of temperature has the effect of instantly changing it to this form (Fig. 21); another piece when placed in the furnace has the same form as the first (Fig. 20), but made of a differ-

Fig. 20

Fig. 21

Fig. 22

ent grade of porcelain. A considerable excess of temperature has no appreciable effect upon its form or color and there is little tendency for it to assume a spheroidal shape. (Fig. 22.) The difference in these porcelains is all in favor of the latter grade, for it permits of more or less abuse and does not require the skill of an expert to obtain satisfactory results.

A porcelain which has a tendency to assume a spheroidal form upon receiving a slight excess of heat will also have a tendency to bleach or lose color; especially is this so where the edges of an inlay are sharp and well defined.

CHAPTER IV

PRACTICAL APPLICATION OF BLOCK BODIES

Former Conditions A half-century ago dentists were obliged to prepare their own porcelain compounds, carve and fire the same into tooth forms, just as they were obliged to refine and roll to gage their gold plate and solders. Modern conditions have changed matters to such an extent that many necessities of the past are found as conveniences of the present, and, as stated in a previous chapter, the large assortment of ready-made teeth provided by the manufacturer has relegated block bodies to the use of the isolated specialists who think they can carve teeth better than the manufacturer can mold them. The ordinary practitioner of today might spend years in carving and manipulating porcelain into tooth forms only to produce in the end poor imitations of teeth which can be secured in the supply houses for a small expenditure of time and money. While all the above is true, and while it demonstrates the fact that practically all of the artificial teeth used by dentists are products of the manufacturer, nevertheless there is a field for the application of block bodies by the dental artist.

Unless the student or practitioner has peculiar talent for this kind of work, and unless he is willing to provide himself with the necessary firing facilities and to devote much of his time to the compounding of porcelain and practice of manipulating the same,

he will do well to give up all thought of employing block bodies and rest content either with teeth as they are made by the manufacturer or else be content to have the specialist in "carved work" make teeth for him.

If the student or practitioner has genius in this direction, and is willing to provide himself with the necessary firing facilities and is ready to devote much time to the practice of making hand-carved teeth, he may develop a skill which will enable him to produce teeth for special cases which will prove superior to anything which is "ready made."

Qualities Required in Block Body

Before outlining the technic of making teeth by hand it will be well to devote some time to a description of the qualities which the porcelain compound, suitable for this class of work, must possess. Briefly stated, a porcelain suitable for the production of hand-carved artificial teeth must be plastic enough to permit of carving and have no tendency to flake or crumble. It must, when fired, possess strength enough to withstand all manipulations necessary to attach it to the base (soldering, vulcanization, etc.), strength enough to withstand all practical strain when in the mouth; it must be natural in physical appearance and capable of withstanding all action of oral secretions.

The essential qualities above enumerated are so widely different in character that it is impossible to find all of them embodied in one grade of porcelain, and for that reason it is necessary to use a "body" which will give the essentials of plasticity, form, and strength, and an enamel which will give the essentials of naturalness, which includes translucency, shade, etc. Owing to the fact that practically all dentists rely upon the manufacturer for

The Lack of Demand

their supply of artificial teeth, and to the fact that there is very little use for block bodies outside of tooth-making, there is little or no commercial demand for the same, and so the dentist who takes up this class of work is compelled to compound his own porcelains or else place special orders with the supply houses.

The preparation of the basal materials entering into the composition of dental porcelains, the compounding of the prepared materials, and the variety which must be made in order to meet all practical requirements is a business of itself, and the busy dentist will soon appreciate this fact if he undertakes to make his own compounds.

Formulas for making block bodies and enamels could be given in unlimited number, according to peculiar working qualities desired and the variety of color necessary to meet all dental requirements.

Making Porcelain Compounds

Owing to the fact that each of the raw materials entering into the composition of dental porcelains varies greatly in character, it seems unwise to give definite proportions with any sort of guarantee that a definite result can be produced. By this is meant that a formula printed in this book, read by dentists in all sections of the country, compounded from raw materials picked up locally by the persons working the compound, would result in the production of "bodies" widely different in character. Generally speaking, a practically infusible grade of silex is used to maintain form, kaolin to impart strength and plasticity, feldspar to produce the necessary glazing and translucency, and the oxides of metals to give the various coloring effects.

If all silex, all kaolin, and all feldspar were alike in character, it would be an easy matter to recom-

mend definite proportions of each for the production of definite results; but such is not the case, and therefore little or no reliance can be placed in formulas generally found in text-books. If the reader desires to manufacture "block bodies," there is only one satisfactory way to do it, and that way is to test all the varieties of the raw materials he can find, select the variety of each best suited to his needs, and compound them in varying proportions and by different methods until the desired result is obtained, keeping careful record of each experiment as made.

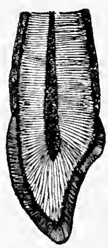
Practical Application of Block Bodies The technic of making an artificial tooth by hand may be described as follows: A plaster impression of the adjoining and occluding teeth, and models from the same are made in the usual way. The models should be thoroughly varnished and then oiled slightly, preferably with olive oil, in order to permit the easy removal of the porcelain after the carving has been done.

The body can be mixed first upon a porcelain or glass slab and then in the palm of the hand, working it with a bone spatula or the fingers until it is free from air bubbles and of a consistence similar to putty. Take enough of the mixed body to fill the edentulous space, and with a suitable carving tool carve the body to the desired shape, making allowance for shrinkage, which should be about 20 per cent. The amount of shrinkage and strength of the finished tooth will depend greatly upon the amount of water which is in the putty-like mixture and the manner in which it is used during the carving. In order to secure the minimum amount of shrinkage, the mixture should be as dry as it is practical to work it and it should be condensed as much as possible. In order to work the body fairly stiff without causing "dry

cracks'' and rough places, it is good practice to press the body in place as much as possible with the fingers and proceed to carve, then when either ''dry cracks'' or rough places occur moisten the body with a camel's-hair brush which has been dipped in water, and with it smooth off the rough place and fill in the fissures.

The approximate form of the desired finished tooth should be made of body, although in many cases it is better to shorten the cutting edge somewhat and leave it rather thin, so that the enamel which is to be fired over the body will be distributed the same way as is the enamel in a natural tooth. (Fig. 23.) The

Fig. 23



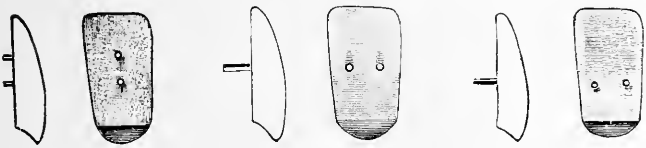
shape given to the lingual surface of the carved tooth will depend upon the use to which the finished tooth is to be subjected. If made to be used for

Fig. 24

attachment to a rubber base, it should be formed as shown in Fig. 24. If to be used for attachment to a metal base, it should be as shown in Fig. 25.

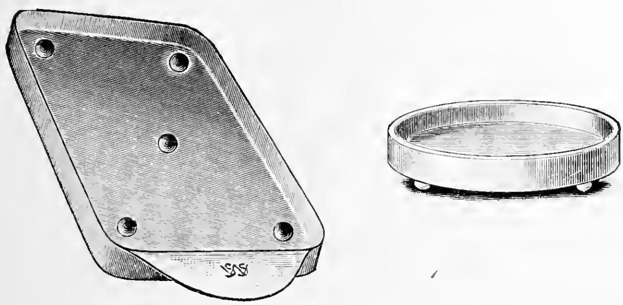
FIG. 25

Pins lengthwise — Pins crosswise — Pins crosswise near the neck



Drying the Body When the desired shape and form have been given the tooth, it should be carefully dried by holding it in front of the furnace or by passing it gently through the flame of a Bunsen burner, and when dry enough to permit of handling it can be placed in a suitable platinum or fire-clay support (Fig. 26) which has been previously covered with

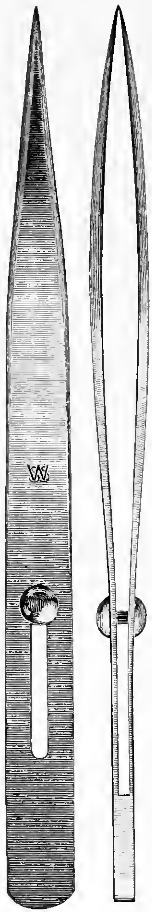
FIG. 26



The Use of Silex coarse silex. The object in using silex in the firing pan or slide is threefold: it overcomes all tendency of the porcelain to adhere to the pan, it makes a porous bed of hot particles through which the heat can permeate to thoroughly glaze the under surface of the porcelain, and it also permits of gradual cooling after the firing of the porcelain is complete.

The platinum pins can be placed in the tooth at this stage of the making, if it is so desired, or they may be put in place after the first firing when the tooth is in the hard-biscuited condition. If placed in position before any firing has taken place, precaution must be taken to moisten the end of the drill before using it to make the holes for the reception of the pins. When the pins have been placed in position, the tooth is ready for the firing process.

Fig. 27



Firing the Body After all moisture has been driven from the carved tooth, it is placed in the furnace and subjected to a temperature necessary to hard-biscuit the same. It is then removed from the furnace, allowed to cool, and if any grinding or alteration is necessary it may be done by the use of sand-paper disks or abrasive wheels.

Enameling The desired shade of enamel can be mixed in a small mortar or saucer to the consistence similar to thick cream, and in this condition it can be applied to the biscuited body in about the same way in which the enamel of a natural tooth covers the dentin or bony portion of the natural organ.

Grasping the pins of the biscuited tooth in a pair of self-locking tweezers (Fig. 27) held in one

hand, the tooth should be slightly warmed by passing it over the blue flame of a burner. With a camel's-hair pencil held in the other hand, the enamel is taken up and distributed upon the surface, care being taken to lay it on smoothly and see that no air is inclosed in the shape of bubbles.

It is sometimes difficult for the beginner to apply the enamel evenly and in such a way as to produce an even distribution of shade. This difficulty may be overcome to some extent by enameling one-half of the tooth at a time, or by enameling the center from neck to cutting edge, thus giving a side view of the thickness desired, which will act as a guide in distributing the enamel over the entire labial face and cutting edge of the crown. When thus enameled, the surfaces may be smoothed, stained, made uneven to imitate natural defects, or treated in any way according to the result desired.

Staining the Teeth In staining hand-made teeth it is advisable to cut small grooves or lines in the enamel surface, fill them in with the desired stain and paint a film of enamel over it; this will be productive of very natural looking results, and will permit of slight grinding if that should be necessary in the finished tooth.

Firing the Enamel After the tooth has been enameled and stained to the artist's satisfaction, it should be placed again upon the silex-covered slide or pan and placed in a position on or near the furnace, where it will receive a gradual drying out.

When thoroughly free from moisture, the slide can be placed in the furnace and the temperature raised to the point necessary to vitrify or produce the desired glaze of the enamel.

Cooling Porcelain Care must be taken to prevent sudden cooling of the fired tooth, and to this end it is advisable to allow the piece to remain in the furnace until cool enough to permit of removal with the fingers; or if the furnace is needed, and time is too precious to wait for the cooling, the piece should be removed while red hot and quickly placed in an annealing oven made of fire clay, the opening of which can be closed up.

The foregoing brief description will serve very well as instruction for working, carving, and firing a single tooth to fill an edentulous gap. The general character of a single tooth can in most cases be easily determined by copying the corresponding tooth on the opposite side, but the task is much more difficult where blocks or sections of sets are to be made or even where odd teeth are desired for an entire denture. **Artistic Study** In the latter cases it is essential that the worker be an observant student of the human face; he must have an appreciative eye and an understanding of the great law of correspondence which determines the size, color, and form of the teeth needed to harmonize with the age, temperament, complexion, physical and ofttimes the moral attributes of the wearer; and, in addition to possessing the power to observe and appreciate these things, he must be capable of making his hands do that which his mind directs. For the carving of blocks, therefore, no directions can be given beyond those already furnished for the making of a single tooth. This kind of porcelain work can only be successfully accomplished by dentists who are artists in the highest sense of the term, and therefore no instructions can be laid down on paper for this class of workmen.

Possibilities Afforded by the Manufacturers Before closing the chapter on block bodies and their practical application, mention should be made of the possibilities rendered practical by the employment of factory-made teeth, the abrasive wheel, and mineral stains. If the time formerly devoted to the making of hand-carved teeth should be utilized by the modern dentist in the study of the manufacturers' stock of teeth and to the alteration of these teeth to suit individual requirements, there certainly would be a marked improvement in prosthetic dentistry as practiced today.

In the stock of the best manufacturers will be found teeth not alone suited to the general needs of the practitioner, but there will be found forms of teeth, both plain and sectional, for metal or for rubber work, especially designed to meet special requirements. By making use of the great variety thus afforded, the modern porcelain worker is equipped with a base upon which it is a comparatively easy matter to work out the esthetic features of a denture. In the chapter on "Staining the Teeth," the modification of manufactured teeth and the aging and staining of the same will be further considered.

CHAPTER V

PORCELAIN CROWNS

Some of the statements which have been made in a previous chapter relative to hand-carved teeth are applicable to hand-made artificial crowns, although the employment of the manufacturers' ready-made facings in the construction of these crowns assists greatly in making this class of porcelain work more desirable. As in the case of artificial teeth which are to be attached to a base, so, in the case of artificial crowns suitable for attachment to the root, manufacturers now provide in their regular stock artificial tooth crowns of many forms and shades, suitable for all ordinary and a few special requirements of practice. For ordinary cases the average dentist will find it impossible to make by hand artificial crowns which will compare favorably in point of strength, adaptability, and esthetic qualities with ready-made crowns of the Logan and Davis patterns; and in some cases, where neither of the above patterns is applicable as supplied, it is far better to use one or the other as a base upon which to build than to make an entire crown by the hand-carved method. There are occasional cases presented which require crowns totally different from either the crowns or facings supplied by the manufacturer, and in such instances one or more methods can be pursued in manipulating porcelain to meet the requirements. If proper firing facilities exist, block bodies may be

The Turner System for Making Crowns

used after the manner described in the chapter devoted to their use, building the body upon the dowel pin and enameling the same in the manner described for enameling single teeth. Another method which offers excellent opportunities for the production of entire porcelain crowns will be found available in the use of "The Turner Porcelain Crown and Bridge System." This method comprises the use of a set of tooth forms, molding

Fig. 28

rings, fusible metal, and instruments for use in connection with these articles. (Fig. 28.)

Briefly described, this system provides for the making of a porcelain tooth in a fusible metal mold,

this mold to be melted away after the porcelain has been poured or packed into it, thus leaving a porcelain tooth in the soft biscuit or molded condition, which can be altered to meet desired requirements.

Practical Application Practical application of this system for the construction of an artificial crown will be described as follows: The root of the tooth to be crowned should be prepared according to the operator's method of preparing roots for the reception of dowel crowns; the post and band adjusted to the root, allowing the post to extend below the roots for about one-third the length of the tooth required. With the post and band in position upon the root, take an impression and bite in the usual manner, from which make plaster models. The metal tooth crowns devised for the pursuance of this method have been made large enough to provide for the shrinkage of the porcelain; therefore select a form which is about one-sixth larger than the desired porcelain tooth and, placing it (occluding surface up) upon either moldine or plastique, inclose it with the molding ring (small diameter up).

Owing to the contour of the metal crowns, it is necessary to make some provision for releasing them from the fusible metal after it has been cast to form the mold. For this purpose it is advisable to place small nickel-plated strips inside of the molding ring in a position which will allow the metal mold to be split in a manner that will release the pattern die. Generally speaking, these little separating plates should be at the mesial and distal walls of the crown, as shown in Fig. 29.

When the pattern tooth has been placed in position upon the moldine, the separating plates adjusted, and the molding ring placed around them, fusible

metal should be melted and poured into the ring, covering the tooth form by an eighth of an inch or so of metal. When the metal sets, but before it is cool, it should be removed from the molding ring, the little

Fig. 29

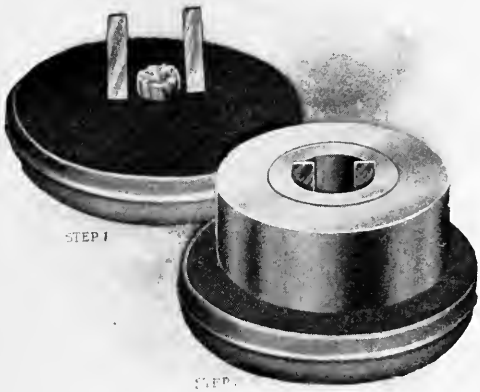
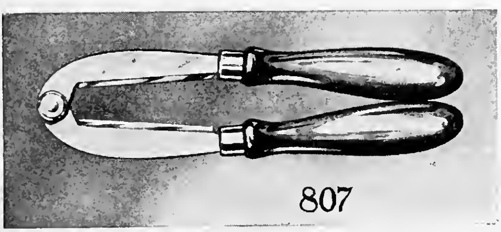


Fig. 30



separating strips knocked away, and, with the aid of a knifeblade and mallet, or, better still, with the Turner dividers (Fig. 30), separate the mold, releasing the metal crown, and then, by placing the parts of

the fusible metal mold together again and placing them back in the casting ring, the mold is ready to receive the porcelain.

In the construction of porcelain crowns made by using a mold such as described there are opportunities for displaying little or much artistic skill. The crown can be made of one shade of porcelain only, or it can be made by blending two or more shades to reproduce natural shades as they exist at the neck and cutting edge of natural teeth.

Solid Shade Crowns If a crown of one shade only is to be made in the mold, the desired shade of porcelain should be mixed with water to a consistence which will just permit of its being dropped into the mold from the edge of a mixing spatula. By dropping the thick mix into the mold, allowing it to strike the sides and find its way to the bottom, by jarring the mold, there is little danger of inclosing air, and thereby forming a blister in the finished crown. As the porcelain settles in the mold the water will remain on the surface—this should be absorbed by bibulous paper or some absorbent cloth; more porcelain is then added, the mold again jarred until the water appears, when it is again absorbed by pressing the absorbent down upon it, and so on until the mold is full, thus making a hard, compact crown, which will permit of easy carving, and which when fired will be hard and dense.

When the crown has been molded, the mold containing the porcelain should be removed from the molding ring, placed in a melting ladle, and the fusible metal melted away, allowing the porcelain crown free to be handled. All particles of adhering metal should be brushed away to avoid contamination with the porcelain, and the crown is ready to be carved;

now the hole should be drilled for the reception of the post, and any change in form which the model indicates should be made, after which it is ready to be fired.

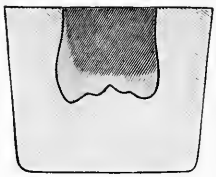
Shading the Crown If a crown is to be made in which two or more shades of porcelain are to be blended, the mode of procedure is the same as that described for a solid shade crown, except that the desired shades of porcelain must be placed in the mold in such a way as to insure the desired color effect in the finished crown. To make a crown in which the cutting edge is a yellowish white, the neck a decided yellow, and the shade of the labial face a gradual blending of the shades in the cutting edge and neck, make the fusible metal mold as previously described, following the detail of the work up to the point where the porcelain is to be placed in the mold. Two shades of porcelain are to be used in the production of a shaded crown, having the general shade effect mentioned; therefore select by the shade guide the two colors—one which approaches the shade desired for the neck and another which approaches the shade desired for the cutting edge. Mix each of these porcelains separately either on separate mixing slabs or far apart on the same mixing slab.

The porcelain which is used to produce the cutting edge and assist in producing the desired blend in the labial face should be placed in the mold first, using enough to fill the mold about one-third. Partially dry the porcelain with absorbent cloth, and with a suitable tool distribute it in the mold by removing a part from the bottom of the mold and packing it against the side which is to form the labial face of the tooth (Fig. 31); then drop the other thickly-mixed porcelain into the mold, absorb the water by

pressing with an absorbent cloth, and release the tooth by melting away the fusible metal as before described.

The distribution of the shades of porcelain, as shown in the illustration, permits the darker or underlying shade to show entirely at the neck, and, by reason of its having to show through an increased

Fig. 31



thickness of the lighter shade of porcelain as it approaches the cutting edge, the gradual blending of the two colors is effected.

A crown made from a block body or a good high-fusing porcelain will be found hard enough to permit of all necessary carving. A certain amount of shaping is always necessary in order to obtain proper relation of the crown to the cap and to occluding teeth; this should be done approximately before subjecting the crown to even a biscuit fire.

FACING CROWNS

The Use of Facings The various porcelain compounds now available can be utilized in connection with the ready-made facings, and the resulting crown will generally be far superior to crowns made by the methods before described. The facings sold by the

manufacturers are made from compounds having an extremely high-fusing point; by a molding process whereby the porcelain is thoroughly condensed. This insures good texture and great strength, and they are supplied in a great variety of form and shade. In making application of porcelain in connection with manufactured facings, it is important to reinforce all connected parts with a metal framework.

Metal Framework In the construction of the ordinary cap and collar crown, the root should be banded with a narrow piece of platinum plate of No. 28 or No. 29 gage, using platinum solder (Au., 75 per cent.; Pt., 25 per cent.) to make the joint. To the band a piece of platinum No. 29 gage, or iridio-platinum of No. 30 gage, should be soldered, forming the floor of the cap. The question of form to be given the anchor-post depends upon the shape and size of the canal and upon the judgment of the worker, but whatever the shape of the post, it should be sufficiently long to permit of firm anchorage in the natural root and to extend beyond the floor of the cap far enough to engage the pins of the porcelain facing. (Fig. 32.)

Platinum solder should be used in making all connections, although pure gold can be used if care be taken to have no excess. When pure gold is used in excess there is some danger of it volatilizing and producing porosity during the subsequent firing of the porcelain; this is especially true when block bodies are employed.

The metal framework for bicuspids and molars calls for the same general detail, with the provision of an additional metal post for strengthening and supporting the lingual cusps. Judgment must be exercised in determining the size of this post, for the

reason that too much metal tends to weaken the porcelain, and for this reason a post just large enough for the requirement is indicated. A platinum pin taken from an ordinary vulcanite tooth, and cut in half, is just right for the purpose. (Fig. 33.)

Fig. 32

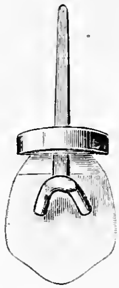
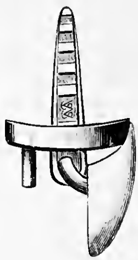


Fig. 33



Applying the Porcelain After the metal work has been completed, pickled, tried in the mouth, and found satisfactory, the piece is ready to receive the porcelain.

Cleanliness is essential in mixing the porcelain, which should be placed on a clean glass slab and mixed with clean water to the consistence of dough. Holding the work in a pin-vise, apply the porcelain and conform it to the minutest crevices by tapping the handle of the vise with the mixing and carving tool.

The tapping will bring moisture to the surface, where it should be absorbed with blotting-paper or other absorbent material. Gradually add the porcelain until it assumes the general form and proportion desired in the finished crown. At this stage it is ready to receive the first firing. Saddle-back teeth, countersunk pin teeth, and Logan crowns can be used

in the same manner as facings, porcelain being filled in between the cap and tooth. (Figs. 34, 35, and 36.)

FIG. 34

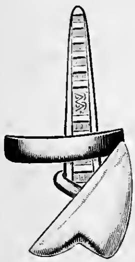


FIG. 35

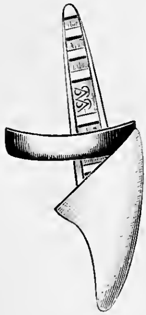
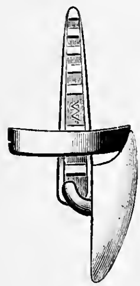


FIG. 36



Firing the Crowns Crowns which have been made as above described will have to be subjected to more than one firing, owing to the fact that the first fire will cause shrinkage, which, in turn, causes fissures in the porcelain.

Biscuit Fire In the first firing of a crown it is only necessary to carry the temperature high enough to effect shrinkage, thus showing the worker where the filling-in must be done. This is called the "biscuit fire," and is recognized as that stage of the firing process when the porcelain becomes hard but not glossy, when shrinkage has taken place, and the mass seems to be covered with minute, shining particles. If allowed to remain in the furnace until the porcelain is glazed, the chances are that in the final firing the porcelain will "sputter," and thus produce a porous, weak, and dirty-looking crown. A crown which has been made of good porcelain and properly biscuited will have lost about one-sixth of its bulk in the biscuit fire. After the crown has received its

biscuit "fire," it can be tried upon the articulating model and the porcelain ground off or added where necessary to proper occlusion and approximal contact. For the second, which is generally but not always the final, firing, the desired shade of porcelain is mixed and carefully added to the crown until it is slightly larger than is required. Experience

Fig. 37

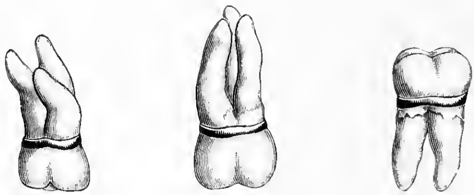


Fig. 38

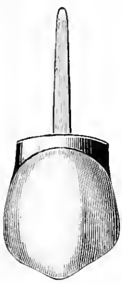


Fig. 39

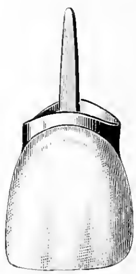
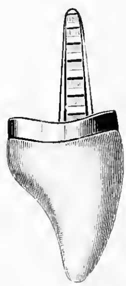


Fig. 40



only will determine just how much extra porcelain will be needed; it all depends upon the care taken to absorb the moisture during application of the porcelain and upon the grade of porcelain used. If the porcelain is "wet" when applied, the fire will cause more shrinkage than it would if the porcelain had been applied dry, that is, with the minimum of mois-

ture. In the final firing, the heat should be applied gradually and the crown allowed to remain in the furnace until the porcelain assumes a smooth, glossy surface corresponding to that of natural enamel.

Fig. 37 shows three finished molar crowns made of solid porcelain, no facings being used.

Figs. 38, 39, and 40 show finished anterior crowns with facings.

CROWNS FOR EXPOSED ROOTS

There is sometimes presented a case for crowning in which recession of the gums has exposed a considerable portion of the root, thus throwing the gingival margin out of alignment with that of the adjoining teeth. In such cases a porcelain crown can be adjusted and will often be productive of better results than can be achieved by any other method of restoration. A cap and collar crown is indicated, and the method of constructing it is practically the same as that described for the construction of a porcelain crown with porcelain facing.

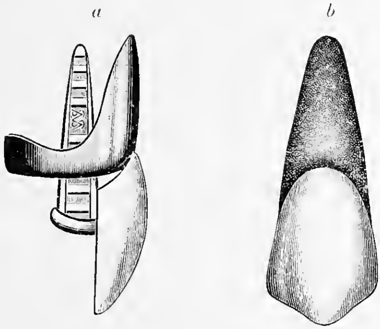
A band of platinum, No. 34 gage, is made to accurately fit the root and follow the line of the gum, and to this band is soldered the floor, making a cap as before described. When making the band for such cases it is advisable to first make a pattern of tea-lead or of tin-foil. This is readily done by cutting the pattern metal approximately to shape and then laying it upon the root and swaging it to place with an eraser on the end of a lead pencil, pieces of spunk, or any other easy method which may suggest itself. If the platinum is cut to correspond to this soft metal pattern, it will be easily adapted to the root and

outline of the gum. When an accurate fit is obtained, the band soldered and attached to the floor, the pin should be fitted to place, the porcelain facing soldered to the post, and the whole placed in the pickling bath and made ready to receive the porcelain. After the lingual surface of the crown has received its first application of porcelain, and before any firing has taken place, that portion of the band which is to replace the lost gum line should be scratched or roughened with an excavator and then covered with a thin layer of yellow porcelain, after which the crown is placed in the furnace and the porcelain carried to a "biscuit fire." The object of placing a layer of yellow porcelain on that portion of the band which is to receive gum enamel is to give added strength to the crown at this point and also to tone down the color of the gum. A yellow shade of porcelain is recommended because that is the color which is generally indicated for use in connection with gum enamel, but, of course, the judgment of the worker must at all times indicate whether this underlying color should be yellow, brown, white, or some other shade. If a bright, lifelike gum is indicated, yellow as an underlying color will generally give the desired result; while if the desired shade of gum is of a muddy, dark color, brown will be found to give the best results. White as an underlying color will produce a pale gum. After the biscuiting has been done, the shrinkage cracks should be filled in, the proper amount of porcelain added to the lingual surface, the gum enamel put in its proper place, and the crown again placed in the furnace, this time carrying the temperature up to the glazing point of the porcelain. Especial care must be exercised in cooling a crown of this description, for if subjected to draughts

of air or allowed to cool too quickly, minute, hair-like cracks will appear in the gum enamel.

Fig. 41 shows a crown such as has been described;

FIG. 41



a representing the metal framework before porcelain has been applied, and *b* representing the finished crown.

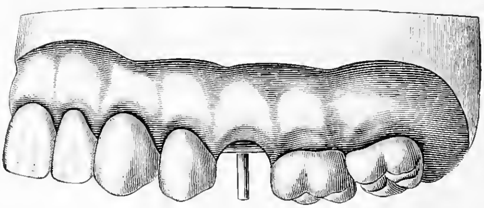
PORCELAIN CROWNS WITH GOLD BANDS

Some practitioners have objections to the application of porcelain crowns owing to the fact that platinum must be used for the construction of all metal parts. The chief objection to platinum in this connection lies in the fact that it is dark in color, and where bands are exposed to view a dark line is apparent, which suggests decay. It has been suggested that in such cases as mentioned the finished porcelain crown can be subjected to a plating solution, which will deposit upon its metal parts a substantial layer of gold, thus overcoming the color objection.

Another method of making crowns whereby the desirable features of an all-porcelain crown can be ob-

tained without the objectionable features of platinum is by the use of crowns similar in form to the English tube teeth. These crowns may be made after the manner described for application of the Turner system, a tube of platinum being inserted in the center of the little metal mold and the porcelain packed around it, or a hole can be drilled through the biscuited crown before firing it to a glaze. In the latter case, of course, there will be no platinum tube, and this is not necessary, because the tooth can be fixed to the post with sulphur or cement instead of soldering, as is sometimes done with the teeth provided with

FIG. 42



a tube of platinum. To make practical application of a crown made as above described, the root should be prepared in the same way as for the reception of the ordinary Richmond crown. A gold cap is then fitted to the root and pin adjusted to the canal, allowing it to extend the entire length of the desired tooth below the band. The post in this case should be round, with a flat filed on the tooth end to prevent turning. This post should not be soldered to the cap until the fitting of the porcelain tooth to the cap has been made, but it should be fixed in position with wax. When prepared in this way, an impression of the parts should be taken with the cap and post in position. (Fig. 43.)

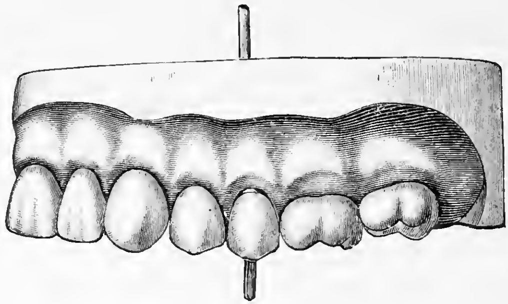
Before pouring the plaster into this impression, the post and cap should each be coated with a film of soft wax, so that when the model has been made the cap and the post can be removed from and placed back into position as often as may be necessary during the fitting of the porcelain. Ready-made crowns like the Davis, English tube teeth, Bonwill, and Foster crowns can be mounted upon roots in this way by grinding them to fit cap and occlusion; but, with the exception of the Davis, these crowns are not carried in the regular stock of the manufacturers, and their employment is therefore almost prohibited. When making a crown from either block body or a high-fusing porcelain, to be mounted upon a gold cap, it is important to make the molded or carved crown considerably longer than the desired finished crown. This must be done in order to provide the necessary amount of material at both the root and occlusal end, to facilitate fitting.

The Use of Pinless Crowns

Having prepared the model so that the cap and post can be easily removed and replaced, remove the post, allowing the cap to remain in its position upon the model; then take a long, thin instrument (thinner than the crown-post), place the point in the hole where the post was, and drill a hole through the plaster cast, taking care to make this hole a straight continuation of the original post hole. The purpose of this hole in the model will be explained later. Now, with the post out of the way, the molded or carved crown may be fitted to the model for approximal contact, occlusion, and position on the cap. When such fitting and adjustment has been made, the crown should be held in position and the long, pointed drill placed in the hole at the back of the model and gently advanced, drilling through the

crown, thus determining the correct position of the hole. (Fig. 43.)

FIG. 43



The hole in the crown should then be made just large enough to accommodate the round post, and this should be done before the crown receives its biscuit fire. In order to keep this hole in its original position and prevent any tendency to close up during the subsequent firings of the crown, it should be filled with fine silex, care being taken not to pack the silex, but to place it in the hole without using pressure. Silex is infusible at temperatures required to glaze dental porcelains. It will not shrink, so it can be readily removed when the crown is finished and ready for mounting. The method for firing the pinless crown is the same as described for either the carved or porcelain facing crown. The post should now be permanently soldered to the cap, and the final fitting of the porcelain to the gold cap can be accomplished by "inking down" the joint. This is done by mixing Prussian blue with oil, applying it lightly to the surface of the porcelain to be fitted, grinding where indicated, and trying it on the cap from time to time until a good joint has been secured. When

Another Use for Silex

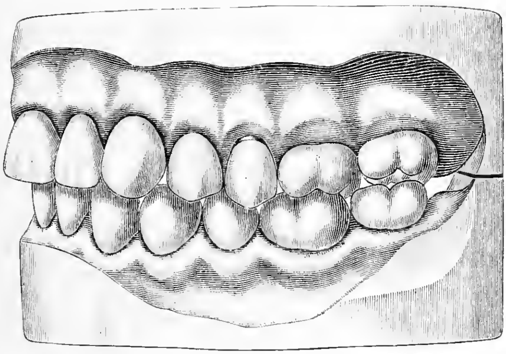
making this joint between cap and porcelain, care must be exercised not to shorten the bite, and thus destroy the articulation.

MOUNTING

Attaching Pin to Crown

When the crown has been cleaned by removing all traces of oil, etc., and the post roughened to facilitate attachment of the luting material, the crown can be mounted, using either sulphur or cement for the purpose. If sulphur is used, it should be melted in a porcelain cup, and, when in a fluid condition, dipped from the cup with

Fig. 44



a sharp-pointed instrument and dropped into the hole of the crown, which should be gently heated. Capillary attraction will cause the sulphur to run into all interstices, and any excess which may run over can be cut away with a sharp-pointed instrument when the sulphur becomes hard.

Fig. 44 illustrates a second bicuspid made and adapted as above described.

CHAPTER VI

PORCELAIN FILLINGS

The modern porcelain filling has attained its present popularity through the improved facilities which have been made available for the manipulation of the material.

Porcelain Fillings Not New

Notwithstanding the fact that the profession as a whole made little use of porcelain as a filling material until the few years just past, the underlying principles for its employment were made known as far back as 1886.

The principles governing the preparation of the cavity—the making of a metal matrix, the firing of the porcelain, and the setting of the finished inlay—were fully described by Dr. Chas. H. Land, of Detroit, Mich., in articles published in the *Independent Practitioner* of August 1886, and February 1887. With the exception of a few enthusiastic dentists who appreciated the inherent merits of porcelain and who have been willing to accept all of the difficulties attending its application to dentistry, this material received little attention until, as before intimated, modern conveniences made its employment practical.

Those men who made practical use of porcelain between the time of its introduction and the beginning of the present porcelain era have been persistent in their statements that "porcelain restorations are practical and have stood the test of time." These statements have been made in the face of adverse

criticism and even ridicule, and it must now be a source of much comfort for the pioneers to witness the interest in and hear the favorable claims which are now made for this tooth-saving and tooth-restoring agent.

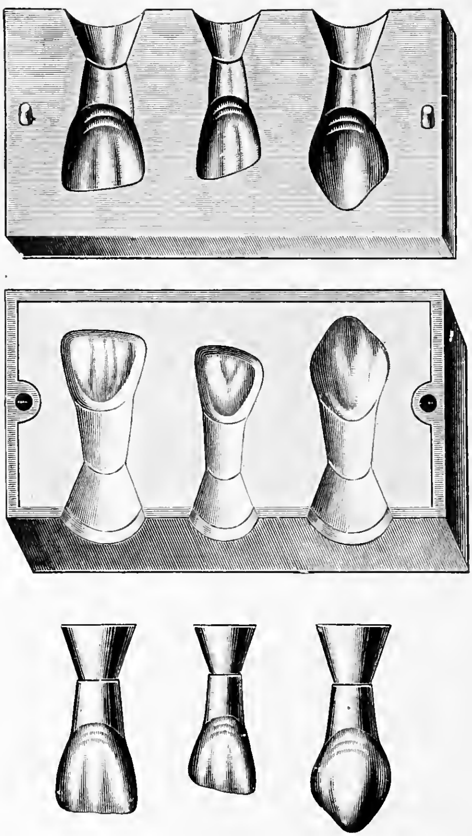
By some practitioners porcelain is regarded as the ideal material for filling the natural teeth, thus claiming for it all the essential and desirable features which that long-sought-for material should possess. Others think porcelain is indicated only in those cavities which are conspicuously located and in which fillings are not subject to the force of mastication. The esthetic results capable of acquirement by the use of suitable porcelain probably appeals to the average dentist more than any other quality. This quality, while very desirable, is not absolutely essential, and if porcelain is to be regarded as a suitable material for filling teeth, it must possess the essential qualities.

Value of Porcelain Porcelain workers of experience now claim that inlays are more durable than the average gold filling; that recurrence of decay around the margin of an inlay is unknown. If this is so, then we must credit porcelain inlays with the quality of durability. Porcelain is compatible with natural tooth structure, its esthetic qualities are unsurpassed by any other material, and it is now practical to employ it.

In addition to possessing these essentials, the necessary formation of the cavity to receive a porcelain inlay makes it an available and desirable filling material for the teeth of nervous individuals who cannot tolerate the long sittings necessary for the insertion of metallic fillings. Another claim made for inlays is to the effect that recurrence of decay, should

it occur, is readily discovered under fillings which owe their retention to adhesion, while decay under fillings which owe their retention to the shape of the cavity is often undiscovered until pulp infection has

FIG. 45



taken place. It will be understood from the foregoing claims made for porcelain fillings that there is good reason for their existence. The proper manipulation of porcelain in the construction of inlays calls for the exercise of much judgment and skill. The knowledge

of the dentist, the judgment of the mechanic, and the skill of the artist are all required if the full complement of porcelain's qualities is to be made manifest.

Experimental Work Experimental work, and plenty of it, should be performed in the laboratory before making practical application to natural teeth. The technic of porcelain work differs from all other heretofore

FIG. 46

performed by the dentist. Starting with the preparation of the cavity and following it through the processes of matrix formation, mixing and application of the porcelain, the running of the furnace and firing of the inlay, its subsequent cooling and insertion in the cavity—all these steps necessitate practice before the best results can be obtained.

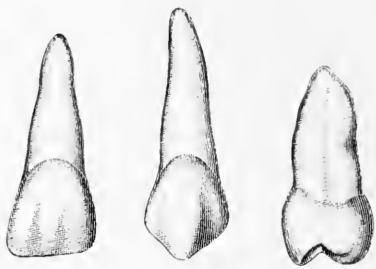
For the convenience of the novice, some of the manufacturers offer experimental outfits, consisting of molds for the making of technic teeth (Fig. 45), ready-made technic teeth, etc. The object of these experimental outfits is to provide a means whereby

the student or practitioner may perfect himself in the technic of inlay making. They afford most of the essentials for practice in every feature of inlay construction, and one or all of these outfits should be extensively used by students who wish to obtain perfection in every detail of the work.

Technic Teeth

Finished technic teeth in which cavities have been prepared (Fig. 46) afford an excellent base upon which to practice the burnishing of the matrix, but for all-around experimental work the biscuited technic teeth (Fig. 47) are better adapted to serve all

Fig. 47



requirements. These biscuited teeth are made from The S. S. White Dental Manufacturing Co.'s High-Fusing Porcelain. They have been pressed in molds, thus rendering them firm and hard enough to be handled and carved at pleasure. Cavities of any description can be prepared according to the individual practitioner's idea of cavity formation.

CAVITY PREPARATION

The student or practitioner who has been accustomed to preparing cavities for other materials

must change his methods and plans when preparing those which are to receive inlays. In the preparation of such cavities the operator must have in mind the removal of the matrix, the taking of an impression, if the inlay is to be made by swaging methods, the strength of the edges of the finished inlay, and the strain which the inlay must withstand during mastication.

Experience has taught us that the thin porcelain veneer is limited in its application to those localities where no strain can take place, and that the so-called saucer-shaped cavity is not at all indicated for the reception of porcelain except in rare instances. The strength of a porcelain inlay depends largely upon its bulk and upon the nature of the force exerted upon it; this is especially true of the edge strength. The advice given by practical men regarding the necessity of perpendicular walls and flat bases shows that this truth is being generally recognized.

Definite rules for the formation of cavities for inlays cannot be established to any greater extent than they can be established for filling materials of another sort, but there are general principles underlying the essential features which may be recommended. The typical cavities illustrated by Dr. A. E. Peck will serve to demonstrate these principles perhaps better than anything else known to the writer; and if the beginner will study them, and will perfect himself in the technic of preparing similar cavities in "experimental teeth" and of making inlays to fit them, it will prove of great help to him when the time comes for making his own modifications of these typical cases to fulfill requirements demanded by practical necessities.

Typical Cavities

Dr. Peck's classification of cavities is as follows:

Cavities involving one surface, labial cavities.

Cavities involving more than one surface, mesio-labial.

Cavities involving mesio-labial-lingual surfaces.

Cavities involving mesio-labial-lingual incisal surfaces.

Cavities involving labial-lingual-incisal surfaces.

Cavities involving the entire incisal edge.

Cavities involving the approximal and occlusal surfaces of the posterior teeth.

Cavities involving the whole occlusal surface of the posterior teeth.

For the purpose of experimenting it is not necessary for the beginner to prepare cavities like all which have been described and make inlays for them, although if this is done, the knowledge gained will be worth the effort. The essential lesson to be learned from this experimental work is that certain mechanical principles govern the preparation of a cavity for the reception of a porcelain filling, and if this lesson be fully understood all cavities will in a manner be alike, embodying as they do the application of a simple principle—flat bases and straight walls.

The Principle Involved

Experimental cavities may be prepared in extracted natural teeth, but unless very strong newly extracted teeth are used, such teeth will be found too weak and brittle to withstand the necessary cutting and subsequent treatment required in either burnishing or swaging the matrix. If the beginner will use the technic teeth provided in the experimental outfit, he will find them much better suited for

the purpose, for they can be cut with disks and ground with abrasive stones without danger of splitting, and they will stand the necessary burnishing and swaging without fracturing at the edges.

Perhaps the best technic teeth available for the preparation of cavities are those made by The S. S. White Dental Mfg. Co., and which are supplied to the profession in the soft-biscuited condition. These teeth are made in forms of centrals, laterals, cuspids, and molars (see Fig. 47). The porcelain from which

Fig. 48

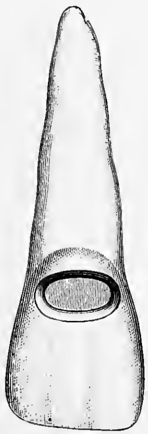
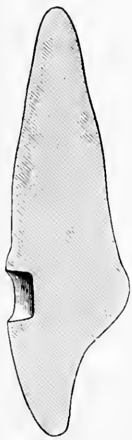


Fig. 49



Shown twice the actual size

they are made can be carved to any desired form, and it can be fired in any of the ordinary electric furnaces which dentists are now using. Taking one of these biscuited teeth for the purpose of illustration, the technic of preparing several cavities involving different surfaces of the tooth may be described as follows:

Fig. 48 shows an enlarged view of a cavity on the labial surface of an incisor which has been prepared for the reception of a filling, illustrating the general

outlines and the perpendicular walls. A sectional view (Fig. 49) of the same tooth shows the depth of the cavity, the perpendicular walls, flat base, and slight curve at the juncture of the walls and base.

Fig. 50 shows a cavity involving part of the labial and part of the approximal surface. It shows the general outline of the cavity, the straight walls, and the retaining groove running along the lingual wall. The second view (Fig. 51) shows the straight walls and

FIG. 50

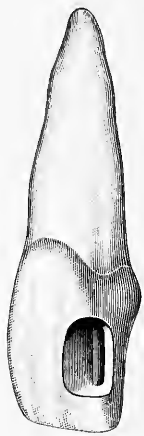


FIG. 51

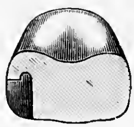
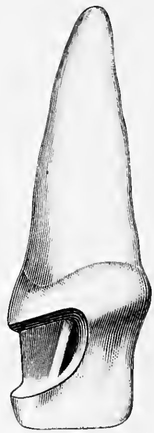


FIG. 52



the depth of the groove. A practical cavity of this formation can be filled with but little separation of the teeth.

Fig. 52 shows a view of a cavity involving part of the labial, approximal, and lingual surfaces. This cavity is of the same general formation as that shown in Fig. 50. The lingual wall has been cut away and the retaining groove cut in the body of the tooth, thus making the finished inlay wedge-shaped, with the small end toward the labial wall.

Fig. 53 shows a cavity involving the cutting edge. An inlay made to fit this cavity will be wedge-shaped, with the small end toward the labial wall and the retentive ridge running along the top and part way along the sides.

To prepare experimental cavities such as have been described, a square-end fissure bur should be used to make the flat base, the corners at juncture

Fig. 53

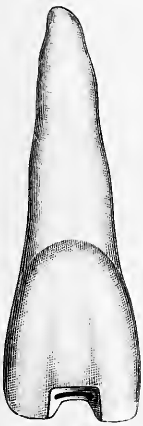


Fig. 54

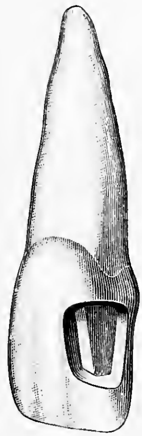
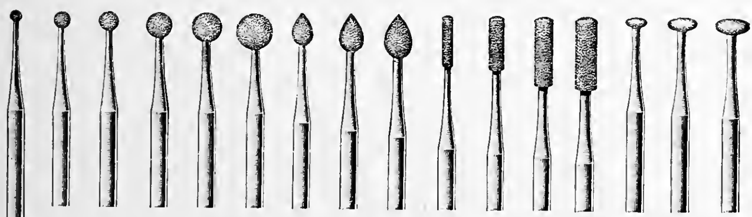


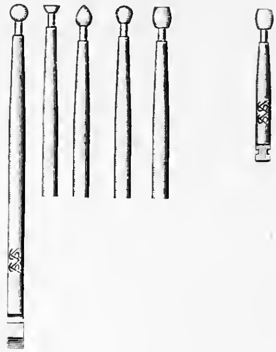
Fig. 55



of walls and base should be slightly rounded with a pear-shaped bur, and the walls made perpendicular with the side of a fissure bur.

When the teeth have been fired, the walls and edges can be made smooth and sharp with either diamond burs or very fine abrasive points. (Figs. 55 and 56.)

Fig. 56



Having prepared an experimental cavity as described, an impression can be made either by burnishing the metal matrix into the cavity by means of the proper shaped instruments, or by the swaging method or by a combination of both.

Making the Matrix The essential point in making matrices is to obtain a correct impression of the cavity in either gold or platinum foil, according to the kind of porcelain to be employed. That method by which the worker can best bring about this adaptation of the foil to the cavity is the method for him to use. The following method for making a matrix of platinum foil and completing an inlay of high-fusing porcelain will be found generally useful, using a cavity like that shown in Fig. 57 as the illustration: Platinum foil, 1/1000 of an inch, is first annealed by placing it in the electric furnace when the muffle is red hot and allowing it to remain in the muffle until the foil is cool

enough to be taken out with the fingers. This annealing can be done without the loss of any time by using the last heating of the furnace for this purpose; that is to say, when the furnace is being used for the last time on any day, place a sheet of foil in the hot muffle, turn off the current, and allow the foil to remain until the next day, at which time it will be found free from "rattle," soft, and pliable. By keeping a sheet or so of platinum on hand it can be kept ready annealed for use at any time.

Annealing Platinum Foil

Fig. 57

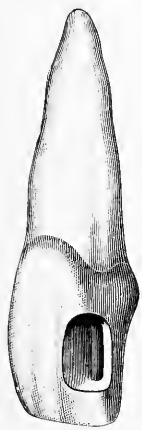
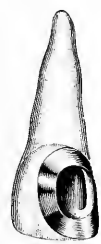


Fig. 58



Cut the foil to approximate shape and a size that will permit of easy adaptation to the cavity, and allow a small margin to overlap the edges to assist in the removal of the matrix, and as a guide for obtaining proper contour when the porcelain is placed in the matrix. (Fig. 58.)

The initial adaptation of the foil to the cavity can be made by grasping pieces of spunk in the beaks of ball-pointed pliers (Fig. 59) and pressing them upon the foil and into the cavity.

FIG. 59

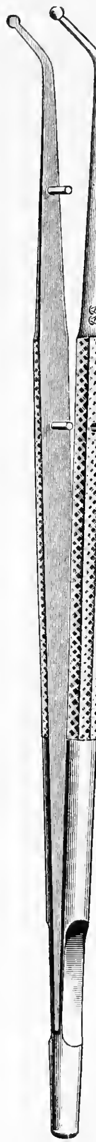
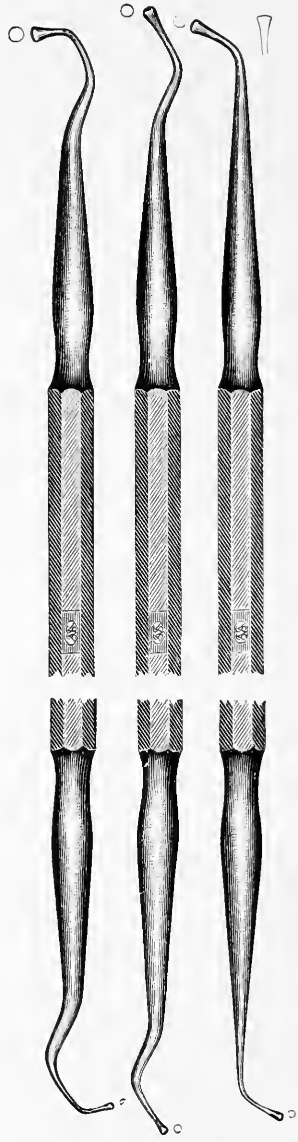


FIG. 60



This pressing of the foil with spunk will cause the matrix to fold upon itself in some places, but these folds can be burnished out with steel instruments. (Fig. 60.) Burnishing will cause the metal to become harsh, and it should therefore be annealed frequently during the fitting, each time placing the matrix in the hot muffle of the furnace rather than in the flame of a Bunsen burner. When annealing the matrix in this way, of course it is not necessary to allow the furnace to cool each time, as was recommended previously for the initial annealing, but simply place the matrix in the muffle, allow it to remain for a minute, and remove. If the initial burnishing is started at the bottom of the cavity by giving a rotary movement to the instrument and gradually burnishing toward the edges of the cavity, the folds in the metal are easier to straighten out than if the burnishing is done from the edges toward the center of the cavity.

To Eliminate Folds

As an aid to eliminating folds as they occur at the edges, it is well to cut V-shape pieces from the overhang; this will avoid "buckling" and relieve the tendency in the metal to spring away from one wall while another is being burnished. When the matrix has been adapted to the walls of the cavity by the burnishing, it should again be annealed, placed back in the cavity, and swaged by using a stick of

Dental Lac as a Swager

Dental Lac. Dental Impression Lac is best softened by dry heat, and this is done by passing a stick of it over the flame of the lamp or burner, taking care not to reach the melting point. Before pressing the Lac into the matrix the cavity and the Lac should be moistened and the Lac pressed into the cavity, thus making a die. Again moisten the Lac die and swage the matrix to the cavity. The matrix usually comes away from the cavity with the

Lac, from which it can be easily removed with the inlay pliers. Should any folds or thick places remain along the edges of the matrix, it can be again burnished and swaged, after which it is ready to receive the porcelain compound.

Dr. C. C. Allen recommends the following method, which greatly facilitates the making of a matrix:

Gum Camphor After obtaining an approximate adaptation of the matrix to the cavity, fill the matrix with gum camphor, pack it hard, thus actually swaging the matrix against the cavity walls. Burnish the edges of the matrix until they are perfectly smooth. To remove the matrix without changing its form, insert a sharp-pointed instrument in the body of the camphor and lift the camphor, matrix, and all out of the cavity. After investing the matrix, the camphor can be burned out, leaving no residue. Should the camphor have become contaminated with blood, it may be removed by soaking for a few minutes in alcohol.

Taking Impressions Another method of adapting a matrix to the cavity, and one which is thought by some to be superior to the burnishing method, is by taking an impression of the cavity, making a model, and swaging the matrix between die and counter-die. The impression can be taken in wax, modeling composition, or cement, according to the subsequent method of using such impressions. If wax is used as the impression material, it should be softened by passing over the flame of a burner and then dipped into soapstone, whiting, chalk, or anything which will prevent it from adhering to the cavity when the impression is taken. When taking the impression of a cavity, it is essential to include in the impression at least a part of the face of the tooth; this will act as a

guide, when building up the porcelain, to obtain proper contour. When the impression has been taken, plaster should be poured into the die cup of a suitable swager, and while still soft, the impression should be imbedded in it and allowed to remain until the plaster has thoroughly set, when the wax can be removed. Over this impression the matrix can be swaged, first pressing it to place and approximately fitting it by pressing with cotton, spunk, or other soft material, after which it can be placed in the cylinder of the swager and the final swaging done with moldine, rubber, or with the water bag.

If modeling composition is used as the impression material, the same general suggestions should prevail regarding the taking of the impression, but cement should be used for making the model in place of plaster. Cement is harder than plaster, and for this reason is preferred by some who favor the swaging method.

Another method of making the matrix has been described by Dr. A. E. Peck, and it is claimed by many to be superior to either of the methods heretofore described, for the reason that it eliminates the thickness of the matrix metal and provides for the making of an inlay which perfectly fits the cavity.

Dr. Peck's Method

Dr. Peck says: "To obtain this result, a correct impression of the cavity must be taken in cement. The convex surface of the impression represents the exact inside of the cavity; the concave surface of a matrix swaged to fit this also represents the exact inside of the cavity. A filling baked to this concave surface after removing the matrix must be a duplicate of the impression, and if contraction and expansion have been controlled, must fit the cavity perfectly."

The technic of making a matrix by the swaging method is practically the same whether wax, modeling composition, or cement is used as the impression material. A correct impression and model of the cavity is an essential, and a perfect adaptation of the metal to the impression or model must be made in either case if a perfect porcelain filling is to be the result.

Ash's Swager The Ash Crown Rubber Block Swager or the Ash Inlay Swager is admirably adapted for the purpose of making matrices, their use according to the claims of their manufacturers affording the following advantages:

"(a) The platinum foil is evenly and perfectly swaged into and around the edges of the cavity by means of the hydraulic pad in the inlay swager; an unalterable matrix is thus secured.

"(b) Foil swaged in this way does not alter in shape during the firing of the inlay because it is free from the springiness which results from the unequal pressure that is applied to foil burnished into a cavity by the hand method.

"(c) It entirely does away with the danger of slightly altering the shape of the matrix, such as always attends the withdrawal of a matrix that has been burnished into the cavity.

"(d) Inlays can be prepared away from the mouth without that frequent reference to patients which has hitherto been unavoidable."

When a perfect matrix has been obtained by either the burnishing or by the swaging method, it should be again annealed, after which it is ready to receive the porcelain. The various grades of porcelain now found upon the market are prepared ready for mixing, and it is only necessary to select the desired

shades and combine each with the mixing medium. For this purpose water, alcohol, and solutions of gum tragacanth have been recommended; but clear water alone is not only all that is necessary, but it is superior to either alcohol or gum solutions for all ordinary work.

Application of the Porcelain It is seldom possible to match the dentin and enamel of the natural tooth by using a single shade of porcelain, although there are instances where the results obtained by the use of one shade will be found "good enough" to meet requirements. In such cases a small quantity of the selected powder should be placed on a clean slab of glass or porcelain, a drop or more of water added, and the porcelain and water combined by spatulating until it assumes the consistence of very thick cream. Different grades of porcelain require to be mixed differently owing to the nature of the component parts of the porcelains and also to the texture to which each has been reduced, but for general instructions it is well to say that the mixture should assume the consistence of thick cream or only that degree of fluidity which will permit it to drop from the end of a brush or spatula and settle evenly over the floor of the matrix.

When applying the porcelain to a matrix fitted to the cavity of an extracted or experimental tooth, the matrix should be laid in the cavity, the mixed porcelain dropped into it from the end of a brush or spatula, and all excess moisture removed by tapping the tooth and by pressing absorbent cloth upon the porcelain.

The amount of porcelain which should be placed in the matrix for the first firing depends upon the form and depth of the cavity and the quality of the

porcelain which is being used; but generally speaking the matrix should be half-filled, and then before placing it in the furnace the porcelain should be scored in sections by using a sharp instrument, this being done to control the shrinkage and prevent it from distorting the form of the matrix.

The Initial Firing Having partially filled the matrix with the mixed porcelain, dried and scored the same, the matrix and its contents can be removed from the cavity, placed upon a fire-clay or platinum pan the bottom of which has been previously covered with silex, and the whole then placed in a position near the opening of the furnace, where it can be gradually heated before being subjected to the firing temperature.

Two Methods of Building Inlays There are two distinct methods of building up an inlay of porcelain, and as instructions for firing differ according to the method used, it will be necessary to refer at this point to the use of a single grade of porcelain throughout the construction and to the combination of two or more grades having different firing temperatures.

It is claimed by some experimenters that all porcelain must be entirely glazed before the maximum amount of shrinkage can take place, while others claim that the shrinkage takes place before the porcelain reaches the hard-biscuited condition. It is due to this difference of opinion that the two methods of building up an inlay are in vogue.

Inlays of One Porcelain When one grade of porcelain is to be used for the entire inlay, the porcelain should not be subjected to a temperature which will glaze the same until the final firing, but it should be subjected to a temperature which will produce shrinkage; and this condition is recognized when the porce-

lain is hard, but not glossy, and the mass seems to be covered with minute, shining particles. If an inlay consisting of one grade of porcelain be subjected only to a "hard-biscuit" fire during the initial application of the porcelain, then the final layer of porcelain can be perfectly glazed without overfiring the porcelain beneath. After the initial firing of an inlay, the matrix can be removed from the muffle of the furnace without any care being taken to cool it, an additional quantity of porcelain mixed, and the second layer placed in the matrix, using great care to fill all the shrinkage cracks and interstices made by the first firing.

If enough porcelain is added to fill the matrix, the second "hard-biscuit" fire should result in the filling of all cracks and leave an even, rough surface for the addition of the third and generally the final fire. When placing the final layer of porcelain in the matrix, it should be applied evenly and made flush with the margins, taking care not to overlap the margins, but to make a fulness which will, when glazed, make a strong, sharp edge.

Inlays of Two Porcelains

Inlays made from more than one grade of porcelain are to be built up in the manner just described, but in the firing of each layer the temperature is to be carried sufficiently high to glaze the porcelain.

The first layer should be of porcelain the firing point of which is considerably higher than the firing point of that which is to be used for the second layer, and the porcelain used for the third layer should have a firing point considerably lower than that used for the second layer.

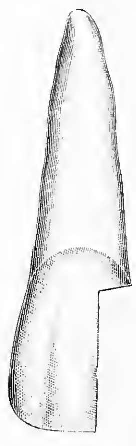
SHADING THE INLAY

The method given above for making a solid color inlay should be followed in the making of a shaded inlay, but in place of using the same shade of porcelain throughout different shades should be selected and so applied to the matrix as to give the desired shade effect in the finished inlay.

It is impossible to lay down any definite directions for the distribution of shades in porcelain work, but it is essential to know that natural shade effects in porcelain can only be produced by blending two or more shades in a mechanical and artistic manner.

Suppose an inlay is indicated to restore the approximal side and part of the incisal edge of an anterior tooth. (Fig. 61.)

Fig. 61



Upon careful examination of the remaining portion of the natural tooth we find that it is yellow at the neck and gray at the cutting edge, and that there

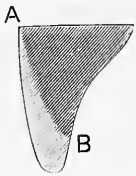
FIG. 62

is a gradual blending of these two colors throughout the body of the tooth.

To make an inlay for such a tooth, the following procedure is indicated: With the aid of a shade guide, select the tints of yellow and gray found in the natural tooth; mix each of these porcelains with water on separate mixing slabs or on one slab which is large enough to keep the two mixings entirely separate. Place the mixed shade of yellow porcelain in the matrix; settle it in place by chattering the matrix with the side of a mixing and carving tool (Fig. 62), or by tapping with the side of some other instrument. Absorb the moisture as it appears on the surface, and when the porcelain in the matrix is of a consistence similar to cheese, carve and build it up as desired. At this stage of the work the initial firing should be made, carrying the temperature only to the "hard biscuit" if one grade is being used, or to a glaze if several grades of porcelain are being used. Yellow porcelain should be used to fill in the shrinkage cracks for the second fire, and if necessary it should also be added at the neck and again blended toward the cutting edge, as shown in Fig. 63. When properly dried, the inlay should again be placed in the muffle of the furnace and subjected to the proper temperature, according to the method used. In the final application of porcelain the gray shade must be used; this is placed in the matrix, filling it flush

with the margins, and when dried the inlay should be again placed in the furnace and subjected to a temperature which will produce the desired amount of glaze. An inlay constructed in the manner described will be found to approximate the blending found in the natural teeth; in fact, it is simply duplicating in porcelain what nature did in distributing the shades of natural teeth. This process of blending colors to produce shade in porcelain has been followed by artificial tooth manufacturers for many years, and it is the only way in which the individual porcelain worker

FIG. 63



can hope to solve the shade question in porcelain work. Modifications of this method will, of course, be necessary. Sometimes the worker will be obliged to make his own admixtures of the manufacturer's ready-made shades in order to obtain the proper underlying colors to begin with; in some cases he will be obliged to mechanically blend more than two colors to produce a desired shade effect; but if the principle of blending colors to produce shade is once understood, the technic for making the special inlay will be apparent to the artist in this work.

CEMENTING THE INLAY

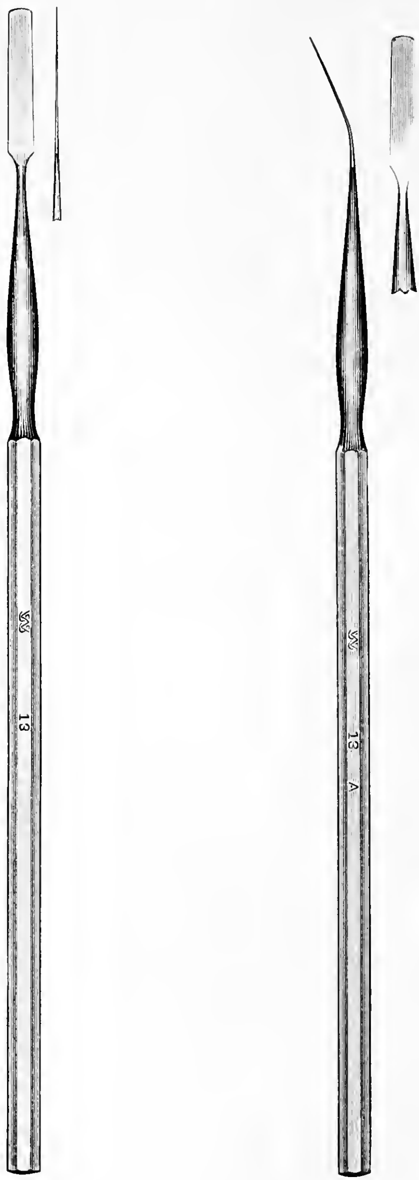
When the inlay is completed, remove the matrix by first loosening it around all the edges with the point of an excavator, and then tease it from the porcelain, working it toward the center of the inlay.

If the inlay be dipped in water after the edges have been started, it will aid in the separation of inlay and matrix; but care must be taken to see that the inlay is cool before this is done, otherwise the water will cause checking. When the matrix has been entirely removed, try the inlay in the cavity, and, if the adaptation is correct, prepare the inlay for its retention in the cavity. This may be done by etching the cavity side of the inlay with hydrofluoric acid or by cutting small grooves with a thin diamond disk (Fig. 64),

Fig. 64

keeping it wet so as to facilitate cutting and to prevent heating of the porcelain, which would cause cracks. The inside of the cavity should also be roughened or undercut so that the cement can take a firm hold on the tooth, thus strengthening the attachment of the inlay. Cement is the best material at our disposal for making the attachment of the inlay to the tooth, and this should be of a quality which will practically set in say twenty or thirty minutes. Mix the cement to a point where it is just fluid, and with a small spatula (Fig. 65) fill the undercuts in both inlay and cavity; then, placing the inlay in the cavity, press one wall in advance of the others so that the air will be excluded. Keep the inlay under pressure until the cement is quite hard. Allow the surplus to remain around the edges without disturbance until the cement is hard, then remove, not by chipping with an excavator, but by the use of strips or paper disks. When practical, it is better to leave this until the next day.

Fig. 65



No. 13

No. 13 A

CHAPTER VII

SHADING PORCELAIN

The proper shading of an inlay or crown calls for the exercise of artistic skill, in developing and employing which the worker in porcelain will find much pleasure and remuneration. The mixing of colors to produce tooth shades is not to be learned from reading, but must come from the hard knocks of experience. Diversified tints of unlimited variety can be produced by altering the proportions of the basal colors, and by the proper blending of the desired tints very natural effects can be produced. The basal color of nearly all teeth is light yellow, and it will be found very practical to use this color in building up that portion of a crown which corresponds to the dentin in the natural organ.

Unnatural-looking Crowns

The unnatural appearance of many artificial crowns is due to the fact that they are of one uniform color, and not of two or three shading into each other, as we find in the natural teeth.

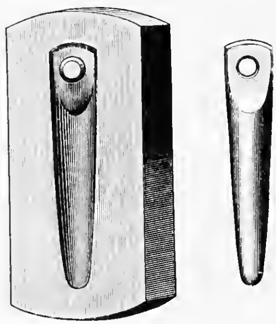
Since the advent of high-grade porcelain in the requisite colors there has been no excuse for solid-color crowns, for it is now possible to closely approximate the natural teeth in their varying shades, even to the staining of fissures and streaking of enamel.

The best way for a beginner in porcelain work, therefore, is to experiment in the mixing and fusing of colors before he attempts the construction of a

practical inlay or crown. This work can be made immediately profitable in experience, for he will need a set of sample shades made from the materials he is to work with. He will find greater satisfaction in working to shades of his own compounding than with any fixed samples of mixes supplied by the manufacturers of the material. Of course, in making these buttons he will need to note carefully the exact proportions in each experiment. He will thus have an invaluable record, and every experiment will serve as a guide in his future practical work; the failures advising him what to avoid, the successes pointing the clear way to useful practical results.

Making Shade Samples A practical method of making new shades from the powders furnished by the manufacturers is to carve a suitable form in plaster, wood, or metal, and from such a form make a mold with Melotte's metal. (Fig. 66.) By the use of such a

Fig. 66



mold new shade forms of uniform shape and size can be made.

Weigh out varying proportions of the different colored powders and mix with water to the consistence of dough, then oil the mold and press it into the

mixed porcelain. If the mold has been properly made, an imprint of the desired form will be made in the porcelain, and this when properly trimmed and fired will record the new shade so produced.

Care should be taken to record the various mixtures so that they may be duplicated at any time. The keeping of such records may be made in this way—using the letters of The S. S. White Dental Mfg. Co.'s porcelain to illustrate: Three parts of A added to two parts of B will produce a new shade, which can be designated as No. 1, or by any name desired, and can be recorded thus: 3 A + 2 B = No. 1. It will be observed that by making shades as here suggested there is no end to the shades that can be produced. To illustrate still further: A is gray, while G is white or colorless, used principally as a modifier to get gradations of other colors:

Make mixtures of varying proportions of A and G, thus: 9 A + 1 G, then another mix 9 A + 2 G, and so on. By combining each of the other shades in this way with G two hundred and fifty gradations will be produced, and this is only the beginning of the possible combinations.

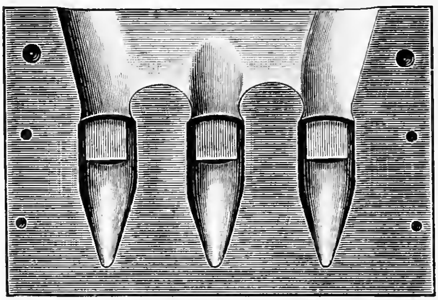
The method just described answers very well if the texture of the porcelain is coarse like that of the Allen and Close bodies; but if the texture is fine, like that of most porcelain now used, there will be more or less difficulty in removing the porcelain from the mold. This difficulty is due to the close adaptation of the fine particles of porcelain.

When making new shade samples from a fine texture porcelain, the same mold (Fig. 66) can be used, but the method of using must be changed. In place of mixing the porcelain with ordinary water and pressing the mold into the porcelain it is advisable to

use gum water and press the porcelain into the mold. The mold containing the porcelain can then be placed in a suitable ladle and melted, thus delivering the porcelain shade sample in a perfect condition. Another mold can be made in a few minutes by flowing metal over the original metal form.

Pouring Method Another method of making individual shade samples may be described as follows: A metal mold, consisting of four parts, can be readily constructed so that the mixed porcelain can be poured or dropped into it and the mixing medium absorbed. Fig. 67 represents the front face of such a mold; Fig. 68, the pouring gate; Fig. 69, the part

Fig. 67



which carries the pins for making the holes in the finished shade samples; Fig. 70, the back face, which holds the absorbent plaster. To make sample pieces in a mold of this description it is necessary to thoroughly oil all working faces, hold the parts together with a clamp of some kind, and then drop the thinly mixed porcelain, drop by drop, into the mold, being careful not to clog up the opening. When the mold is filled, put it aside until the porcelain sets; then open the mold and gently remove the porcelain castings.

When the plaster becomes saturated with the mixing fluid, knock it out of the frame and pour a new back.

Some porcelains, like Ash & Sons' High- and Low-Fusing, S. S. White Dental Mfg. Co.'s Medium-Fusing, and Brewster's Enamel, are easily handled and

FIG. 68

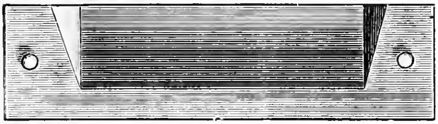


FIG. 69

FIG. 70

FIG. 71

seem to be particularly adapted for use by the pouring method; while other porcelains, like the S. S. White Dental Mfg. Co.'s High-Fusing Porcelain, Close, Allen, and Block Bodies, are better adapted for use in the pressing method.

Something More than Shades Required

With hundreds of shades from which to select, the possibilities of obtaining a desired result will be greatly increased, but it must not be supposed that this variety will be all that is necessary to secure shades as they are found in the natural tooth.

If a section of a natural central incisor be examined (Fig. 72), it will be observed that the dentin which forms the bulk of the tooth is one color and the enamel which covers the dentin is another color. Furthermore, the enamel is thinnest at the neck of the tooth, but gradually increases in thickness as it approaches the cutting edge. Here is a lesson direct from nature, and one which the manufacturers of artificial teeth have learned and put into application. The shades of factory-made porcelain teeth are not obtained by using a single shade of porcelain, as many so-called porcelain workers suppose, but they are made by employing two distinct shades of porcelain and blending them to produce natural shade effects. (Fig. 73.)

FIG. 72

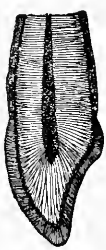
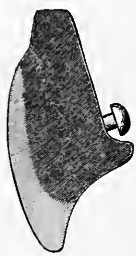


FIG. 73



When making artificial porcelain teeth, the molder places the enamel or light shade in the labial face of the mold, blends it with a hand tool, leaving an open space at the neck. A tip of enamel is also placed at

the cutting edge in the lingual face of the mold. The body or dark shade of porcelain is placed in that portion of the lingual face of the mold not occupied by the tip of enamel, and the two parts of the mold are then put together and the body and the enamel blended by putting the mold under pressure.

The practitioner who expects to obtain natural effects in either crowns or inlays must follow in a general way the methods used by tooth manufacturers. If the underlying color of a crown is yellow and the enamel a yellowish white, select a yellow porcelain to build up that portion of the crown which corresponds to the dentin in the natural tooth and then cover this yellow shade with a layer of the yellowish white or white shade. The same thing applies to small inlays even when the amount of porcelain would appear too small to require more than one color. This blending of two or more shades is the correct solution of the shade problem, and it must be observed if the best results are desired.

CHAPTER VIII

MINERAL STAINS

The observant student will recognize the fact that shades as well as the form of human teeth vary greatly in the same denture. Only on rare occasion do we see dentures in which the pairs of each class are true mates. The left central is seldom like the right central; there is always a difference in the form of the laterals, and so on, each tooth in the denture having its individuality.

The ravages of nature have their effect upon the individual tooth. Mastication, lack of occlusion, disease, etc.,—each does its part in wearing and shaping the teeth until there is little more than type resemblance existing between pairs of teeth which were at one time closely mated in form. At the time of life when artificial teeth become a necessity, the natural organs have been mutilated to such an extent that symmetry is destroyed. It is as unreasonable as it is undesirable to expect manufacturers to make artificial teeth which would be in accord with the innumerable stages of wear and discoloration found in the natural teeth.

Individuality in Teeth

Individual cases requiring artificial substitutes for the natural organs must always require individual effort upon the part of the dentist if he wishes to restore harmony of the features. With the aid of a dental engine and an abrasive wheel, the dentist may age and mutilate artificial

teeth just as effectively as nature by her methods ages and mutilates the natural organs. The shades of individual teeth which enter into the make-up of a natural denture are by no means uniform; they vary greatly in depth of color, and if the individual shade is carefully "taken" it will be found that six or seven shades or variations of the same general shade will be found in a single denture. As a rule, the teeth of artificial dentures are selected at the dental depots and used as they are purchased. If a full upper set is required, a set of fourteen teeth all of the same shade is used. This is wrong, and such practice partially accounts for the incongruous effects which are noticeable in the mouths of those wearing artificial teeth. Deposits and stains also help to break up the uniformity of shade, and to a certain extent these stains must be reproduced in the artificial dentures, especially in partial cases where several natural teeth remain to act as examples of comparison between the real and the false. Modifications which can be made in a single form of factory-made teeth are only limited by the knowledge and skill of the dentist. The abrasive wheel alone can be made to effect variations in age and arrangement which will destroy the identity of the original form, and when we consider the changes made practicable by the use of stains, the possibilities of copying nature are indeed great.

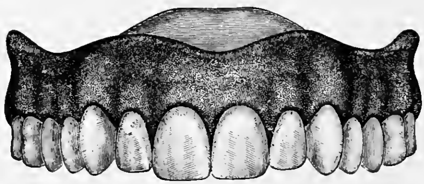
To Effect Changes It is so simple to make changes in the manufactured teeth that the beginner in this class of artistic prosthesis will be surprised at the result of his efforts. As an example of what may be accomplished by the use of the abrasive wheel, take a few sets of anterior teeth all made from the same mold; allow one of the sets to remain untouched for the

purpose of comparison, but take the others and grind them to represent the natural teeth of individuals whom you see every day.

Carry the object lesson a little further by changing another set with the grindstone and then mounting them upon a base-plate of wax, changing the arrangement of the anterior teeth. (Figs. 74 to 80.)

Fig. 74 represents the sanguineous temperament.

Fig. 74

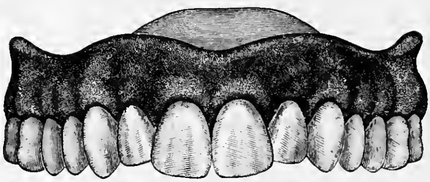


Mold 213

as to the shape, outline, and alignment of the teeth, and the general form, "well proportioned, abounding in curved or rounded outline; cusps rounding."

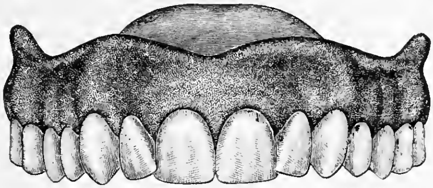
In Fig. 75 there is a strong prominence of the central incisors, with the laterals inclined forward and standing behind the centrals. The arch is somewhat contracted from the cuspids forward.

Fig. 75



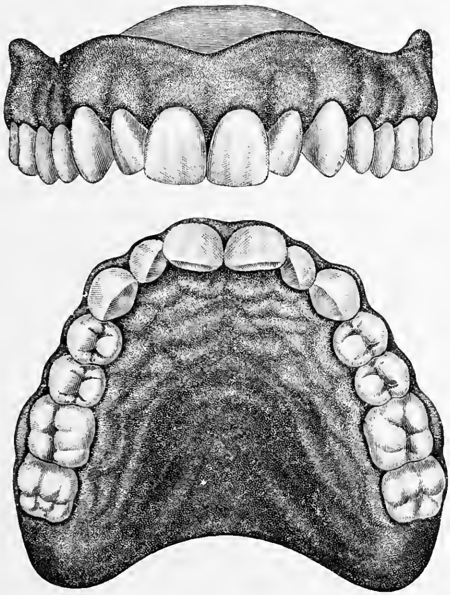
In Fig. 76 there is less prominence of the centrals; the laterals pitched forward enough to overlap the centrals at the tip ends.

Fig. 76



Mold 213

Fig. 77

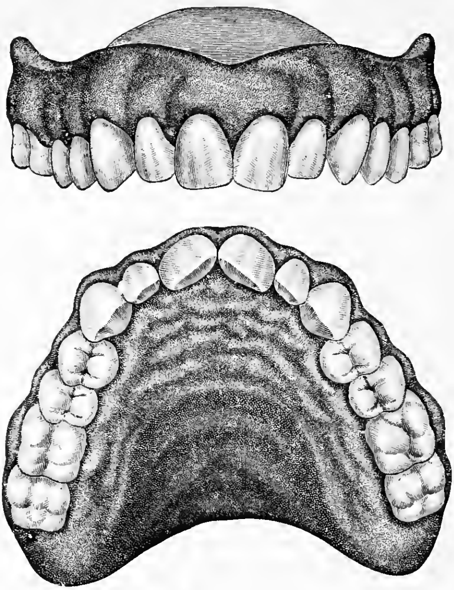


Mold 213

In Fig. 77 the centrals are rotated toward the median line and depressed at the incisal ends; laterals rotated to expose their anterior approximal edges, with a pitch toward the centrals.

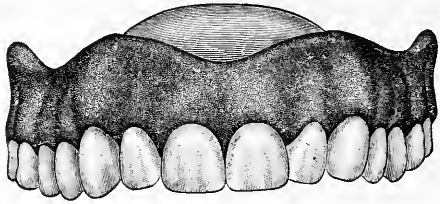
Fig. 78 shows a directly opposite condition from that seen in Fig. 77. The centrals are rotated to form a V-shaped or pointed arch, and with the laterals pitching toward the facial line; the cuspids are so placed as to narrow the arch at the point of their insertion.

FIG. 78



MOLD 213

FIG. 79

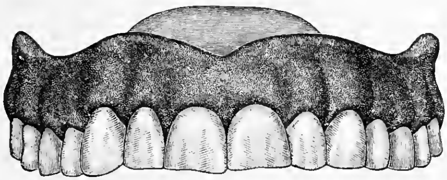


MOLD 213

Fig. 79 shows a common alignment of the incisors, the laterals pitched slightly toward the centrals. The

occlusal ends of the teeth are ground a little to show slight wear, as at the age of twenty-five or thirty years.

Fig. 80



Mold 213

Fig. 80 is an example showing considerable wear, representing the condition of the teeth at, say, fifty years. The teeth are regular in alignment.

It will be seen from the illustrations that arrangement and grinding will do much to disguise the artificial effect of porcelain teeth, and when mineral stains are used in connection with the grinding and arrangement, the disguise may be made nearly if not entirely complete.

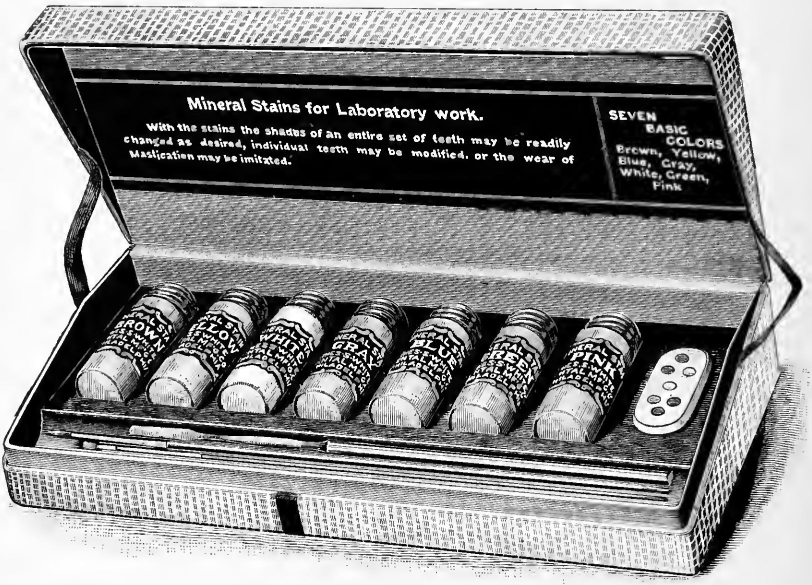
The Stains Mineral stains, porcelain enamels, or oil colors, as they are called, according to the manufacturer who makes them, are pigments made for the purpose of changing the shade or producing artistic effects upon porcelain teeth or inlays. Like the various porcelain compounds found upon the market, these stains vary in character and working qualities according to the formulas and processes employed in their manufacture, and what has been previously said regarding the qualities of porcelain applies with equal force to mineral stains—that is, the only way to become familiar with the working qualities of each make is by actual experiment.

The principal practical application of stains will be found in producing the imitation of wear, the aging

which is shown by stains and deposits in the fissures of the bicuspids and molars and the cutting edges of the incisors, and in the general darkening of the shades of the teeth.

Other opportunities for their employment will be found in the construction of crowns and inlays made from high-fusing porcelains. In this particular application they can be used either as overglaze or as underglaze colors.

Fig. 81



Practical Application The stains are supplied in basal colors—white, gray, blue, brown, yellow, green, and pink or gum color. (Fig. 81.) In some cases some of the basal colors may be used alone, but for general application it will be necessary to make admixtures in order to produce the great variety of shades, stains, and discolorations found upon the surfaces of natural

teeth. To thoroughly learn the effect of combinations of these colors with one another and with the tone color of the teeth which are to be modified, some little experimental work is necessary in order to become familiar with their behavior. In fact, it is always safer to make a provisional or preliminary test of each case as it occurs. A discarded tooth will answer very well as a test piece. Paint on a little of the color or combination which appears to be right and fire it to see whether the proper tint is brought out. This point should be assured before the color is laid on the tooth to be shaded. It takes only a few minutes to make this trial and it will many times prevent serious error.

Make Trials

Specific direction for the production of desired effects cannot be given on account of the difference in quality of the different makes of stain, but general directions for producing some of the desirable effects may be given as follows: If the tone of the tooth is yellow, the addition of brown will first darken the yellow, then, as more and more is added, bring out a more and more decided brown. If the tone is blue or gray, brown at first merely deepens it, but on the addition of a considerable quantity produces a decided brown. A combination of green with brown will give a natural-looking stain similar to that found upon the teeth of inveterate smokers. Natural cutting edge effects may be obtained by using either gray or blue as an underglaze color, *i. e.,* after applying and firing the color, cover the same with the colorless low-, medium-, or high-fusing porcelain and again fire. For representing the wear of mastication, the teeth can be ground and the cutting edges and fissures stained with the brown. White spots frequently seen in the enamel of natural

Specific Uses

teeth can be imitated by applying a thin layer of white. Defects in the enamel, such as pits or grooves, can be imitated by drilling the enamel surface of a tooth and staining with the desired color. The pink or gum color will be found very useful in covering platinum bands which are exposed below the gum line, also in coloring that portion of an inlay or crown which must match the cervical border of adjoining teeth.

Before attempting to apply the stains, the teeth should be made perfectly clean and dry. If they are to be "aged" they should be set up, articulated, and ground upon the cutting edges and articulating surfaces, then removed one by one and stained.

In applying the stain it is important to mix the material until it works smoothly and to a consistence which will permit it to be used after the manner of paint. When so mixed, the stains may be applied with a small, pointed camel's-hair pencil, and then distributed over the surfaces of the teeth by means of the fingers or a stippling brush. If a wavy, granulated effect is desired, the material should be applied rather thick; but as generally required, it should be laid on very evenly and in thin layers, thus producing a suggestion of color rather than a decided effect.

In cases calling for a decided blue at the cutting edge, a milk spot in the labial surface, or the effect of exposed dentin, it is advisable to make a recess in the enamel of the tooth with a diamond disk or drill and then fill this recess with the stain.

Firing the Stains Any good dental furnace capable of firing the block bodies or high-fusing porcelains will serve the purpose for permanently "fixing" all the stains, and some of them may be fixed with the gas blowpipe. There is quite a difference in the

All Stains Not Alike glazing point of the different manufacturers' product. Some of the stains can be fixed at a very low temperature and yet withstand a high temperature; others require a high temperature to properly glaze and fix them, and then will stand very little excess heat without losing their color.

The electric furnace can be depended upon to fire even the very high-fusing stains, and is preferable for the work because of its easy control. The teeth to be fired should be placed upon a tray made of platinum or of fire clay, the pins of the teeth resting upon the tray, and then tray and teeth should be placed on top of the furnace, where they can be made quite warm before attempting to place them in the muffle. Great care must be taken to thoroughly heat artificial teeth before subjecting them to high temperatures; therefore it is advisable to have the temperature of the muffle either cool or else very low when teeth are to be stained. After the teeth have been made thoroughly warm, the temperature can be gradually raised until the glazing point of the stain has been reached, when the heat should be reduced, and when cool enough the teeth can be removed. Sometimes the stains, while producing natural color effects, have a tendency to produce an unnatural glossy appearance in the enamel; when this occurs it can be easily remedied by brushing the tooth with pumice stone.

When properly treated with a good quality stain, artificial teeth can be subjected to all the necessary laboratory manipulations required in mounting and finishing, and they will withstand all practical use in the mouth. The accompanying illustrations will suggest changes which can be made in the appearance of dentures containing stained teeth.

Fig. 82

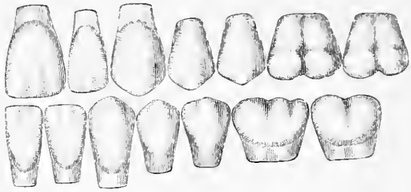


Fig. 83

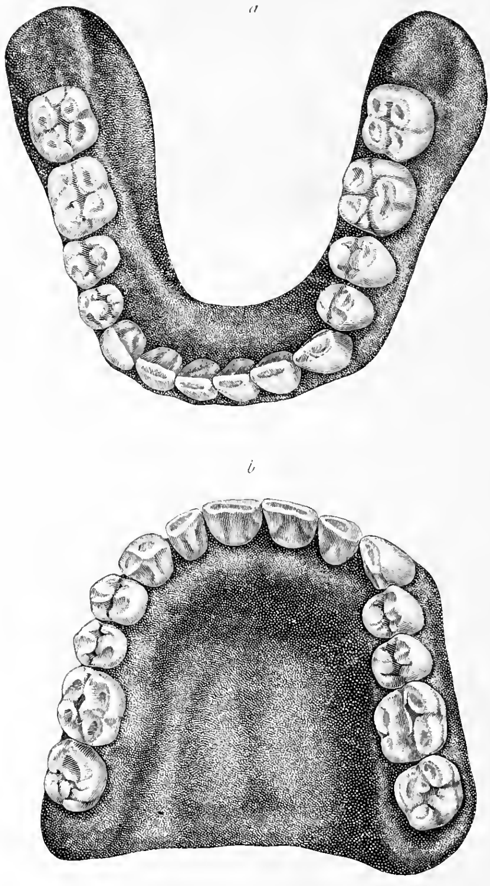
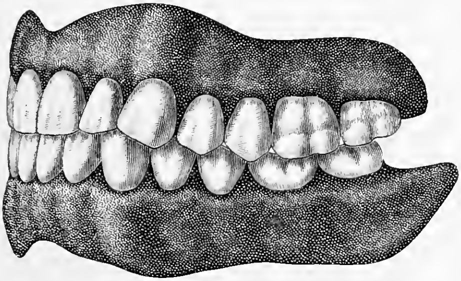


Fig. 82 illustrates one-half of a set of twenty-eight plain rubber teeth as sold by the manufacturer.

Fig. 83, *a* and *b*, show the masticating surfaces of this set of teeth after they have been ground to proper occlusion and stained to represent natural defects.

Fig. 84 represents the same teeth anatomically articulated.

FIG. 84



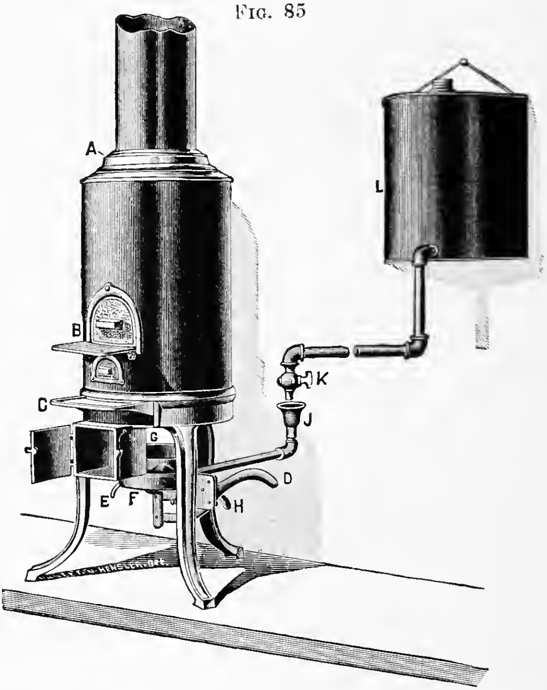
Notice the changes made in the finished dentures by comparing Fig. 84 with the original teeth as provided by the manufacturer.

CHAPTER IX

FURNACES

The furnace required for the firing of dental porcelains depends largely upon the grade of porcelain used, the facilities for installing a furnace, and the preferences of the worker. If block bodies are to be fired, the Revelation Dental Furnace (Fig. 85).

Fig. 85



made by H. J. Caulkins, of Detroit, is by all means desirable; in fact, it is the most practical furnace on the market for all-around porcelain work. Block

bodies require high temperatures to glaze them, and these temperatures have a killing influence on practically everything except fire clay. With the exception of outside parts, the Revelation Furnace is made of fire clay, and it will therefore withstand the block body temperatures much better than any other furnace now obtainable. The furnace requires no forced draft, an ordinary chimney being all that is required in this connection. The fuel, kerosene oil, is obtainable in all sections of the globe, therefore the cost of running the furnace is comparatively low; and last, but by no means least, the worker is not at the mercy of gas or electric companies.

The size and form of the muffle (8 inches long, $3\frac{1}{2}$ inches wide, 3 inches high) admits any piece of work from a small inlay to a full denture of continuous gum, and the even temperature obtained can be depended upon to make the firing perfect.

Operating the Revelation Furnace

To start this furnace it is only necessary to open the cock and allow the oil to flow until the burner is partially filled, then light the oil with a match. When the furnace is started from the cold, it takes about forty minutes before the temperature in the muffle is sufficiently high to fire porcelains of the block body class.

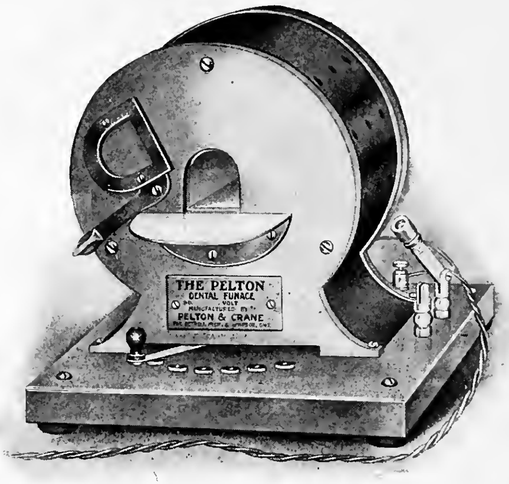
When any desired temperature is once obtained, it is easily maintained by regulating the burner and the flow of oil. To stop the furnace it is only necessary to close the cock which controls the flow of oil, thus allowing the oil in the burner to be consumed in a few minutes.

Electric Furnaces

In communities where the electric current is obtainable, the electric furnace has found favor. This type of furnace possesses many features which recommend themselves to the operative dentist

—they are compact, easily manipulated, clean, and noiseless, and within certain limits of temperature they are efficient and durable. Notwithstanding the fact that certain manufacturers recommend their electric furnaces for the firing of block bodies, the advice is here given to put little faith in such recommendations. It is quite true that some porcelain compounds which come under the definition of block body

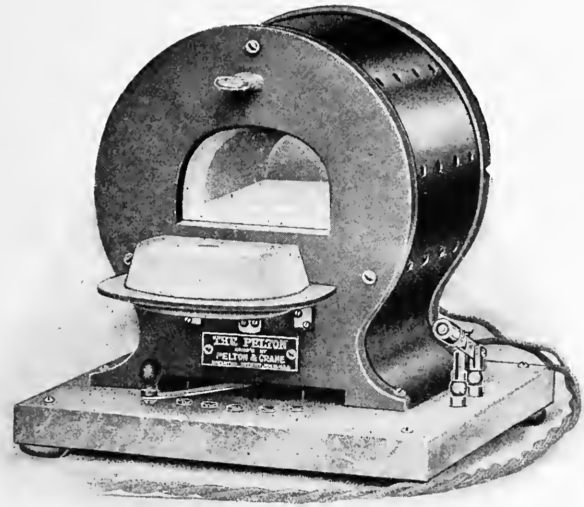
Fig. 86



The Pelton Furnace No. 1

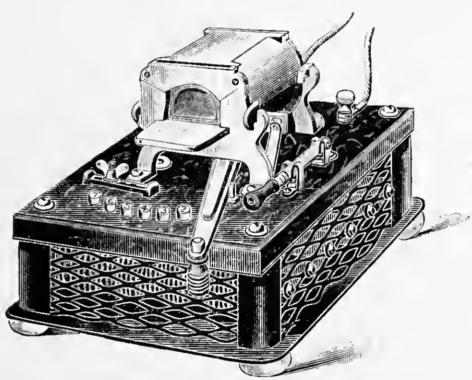
can be glazed in the electric furnace, but, as stated elsewhere in this treatise, the obtaining and maintaining of such temperatures should be regarded in the light of experiment rather than good practice. Again let it be said that block bodies should not be fired in the present type of electric furnace. For high-fusing and low-fusing porcelains any of the well-known furnaces, such as the Pelton, Hammond, and Custer, can be relied upon for efficiency.

Fig. 87



The Pelton Furnace No. 2

Fig. 88



Hammond Electric Furnace No. 2

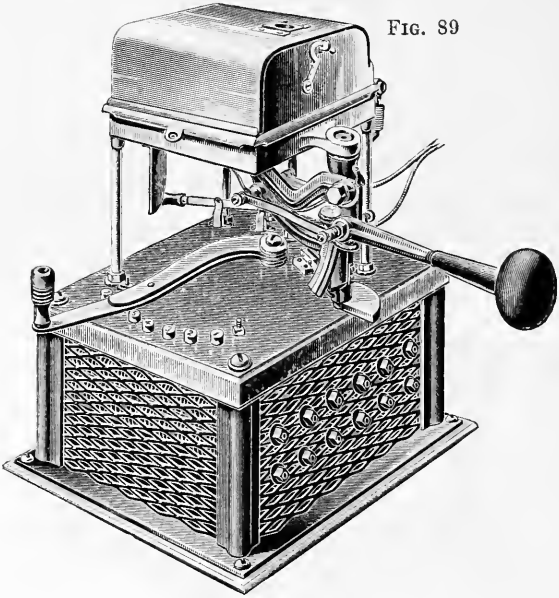


Fig. 89

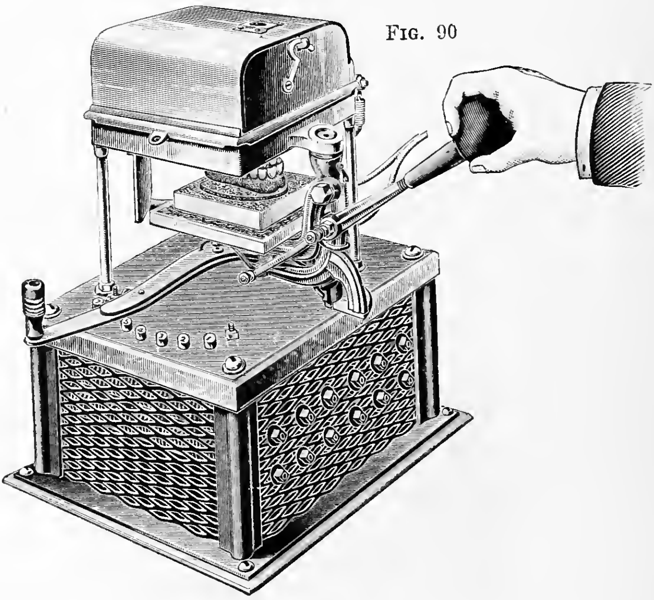


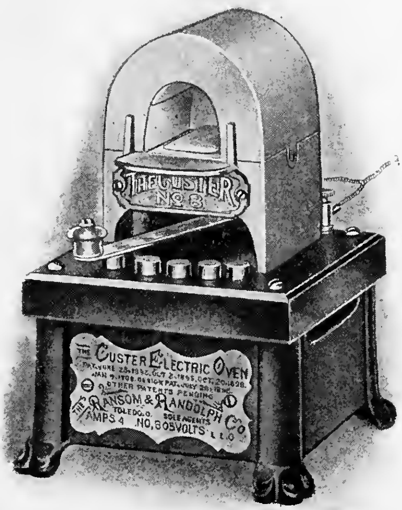
Fig. 90

Hammond Electric Furnace No. 4, Closed and Open

FIG. 91

CUSTER ELECTRIC FURNACE NO. 1

FIG. 92



CUSTER ELECTRIC OVEN NO. 8

These furnaces differ in construction and design. (Figs. 86 to 92.)

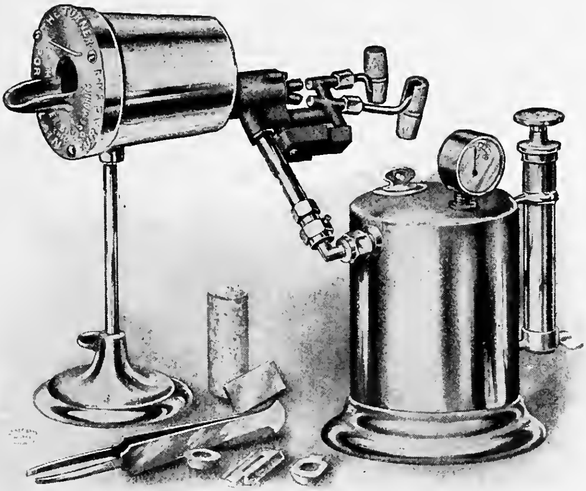
Each possesses special features which appeal to different individuals; therefore every prospective porcelain worker should study these features and select the furnace best adapted to his needs. When operating any electric furnace, the thought should be borne constantly in mind that the heat is derived from the resistance offered by platinum wires to the passage of the electric current, therefore the muffle cannot be heated too high without danger of subsequently causing a break in the wire.

Most of the "burn outs" in electric furnaces are caused by ignoring the above thought regarding the relation of the heat to the wires. Practical experience is the only thing which will make a man proficient in the manipulation of the electric furnace; but if the novice will refrain from attempting to fire porcelain compounds having a glazing point too high for the furnace, and will make it a rule to obtain no higher temperature than is required to glaze high-fusing porcelain in a reasonable length of time, he will have little difficulty in keeping the electric furnace in good working condition.

GASOLINE FURNACES

In small towns and country places where the electric current is not available, gasoline furnaces can be depended upon to fire the high-fusing porcelains. They are preferred by some dentists in localities where the electric current is available, this preference being occasioned by the thought that the gasoline furnace is less liable to burn out and its maintenance costs less than the electric furnace. Furnaces of this type are shown in Figs. 93 and 94.

FIG. 93



TURNER GASOLINE FURNACE No. 140

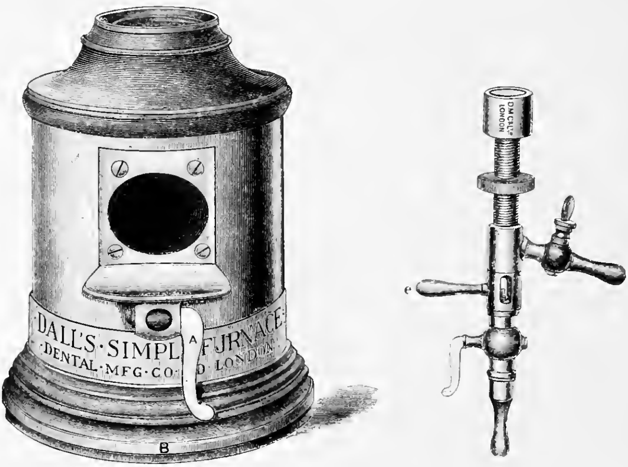
FIG. 94

TURNER GASOLINE FURNACE No. 41

GAS FURNACES

Several types of gas furnaces have been offered as being entirely suitable for the firing of dental porcelains. Most of these have been withdrawn from the market through the lack of commercial demand. Of those which are now offered for sale, Dall's

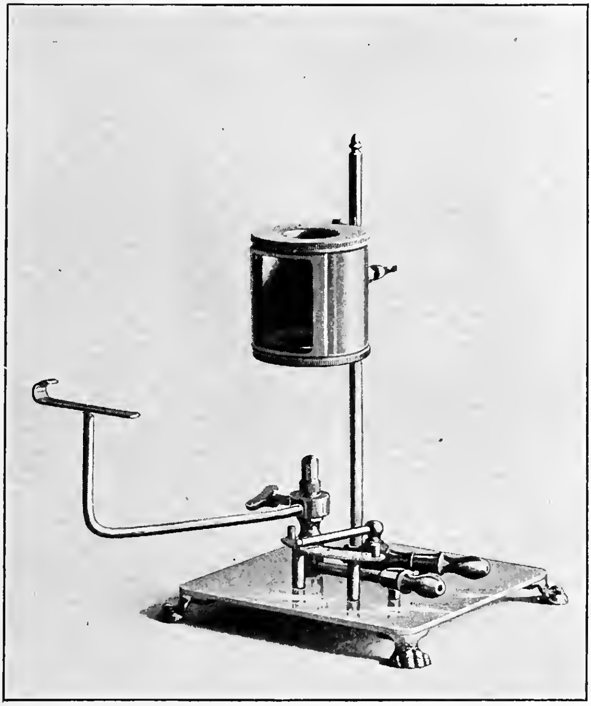
Fig. 95



Simple Furnace and the Jenkins Miniature Gas Furnace can be especially recommended. The Simple Furnace (Fig. 95) was designed by Dr. Dall, of Glasgow, and is neat in form and design. It is compact, comparatively noiseless, and it can be relied upon to properly glaze inlays and crowns made from the Jenkins Porcelain Enamel, Ash's Low- and High-Fusing Porcelains, White's Medium- and High-Fusing Porcelains. The Miniature Gas Furnace (Fig. 96), designed by Dr. Jenkins, has been especially constructed to properly fire the Jenkins porcelain, and for this purpose it is considered superior to

any other design. This Miniature Furnace, as its name implies, is small. It is neat in appearance and comparatively noiseless. The muffle is provided with an opening in the bottom through which the flame of gas can be directed, thus heating the invested porcelain from the bottom. The opening in the front of

Fig. 96



the muffle is large enough to permit a full view of the glazing process, and it also permits easy manipulation of the investment. Owing to the fact that the Jenkins porcelain yields its best results when the heat is directed from below, and that it flows by grav-

ity when melted, both of these openings are of great advantage.

The Jenkins Furnace, which fills every requirement for firing the Jenkins porcelain, is not adapted for firing porcelains the glazing point of which is considerably higher.

CHAPTER X

FIRING PORCELAIN

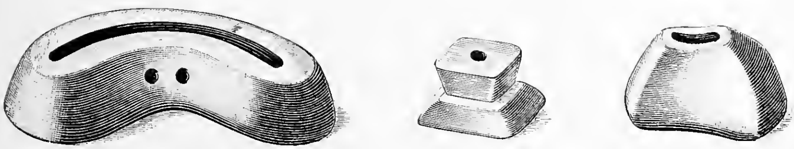
The denture, bridge, crown, or inlay which is to be fired must be placed on a suitable conveyance previous to placing it in the furnace.

For dentures, a slide like that shown in Fig. 97 should be covered with silex and the denture laid upon it, building up where necessary to support the porcelain during the glazing process.

FIG. 97

FIRE-CLAY SLIDE
Shown ½ size

FIG. 98



For bridges and crowns, fire-clay supports, provided with slots and holes for the reception of anchor-pins, are essential. (Fig. 98.)

For inlays, either fire-clay or platinum pans are indicated. All block bodies and most of the high-fusing porcelains can be placed in a hot furnace after all moisture has been driven out of the porcelain and

the object gradually heated to redness. The preliminary drying out and heating is best accomplished by opening the door of the furnace, placing the object to be fired far enough away to prevent too rapid heating, then bringing it gradually up to the opening of the muffle, then when thoroughly heated placing it in the muffle and closing the door. In firing some of the high-fusing porcelains and all of the low-fusing it is necessary to start with the temperature in the furnace very low. If this precaution is not taken, and the effort is made to fire under the same conditions mentioned for firing block bodies and some high-fusing porcelains, there will be difficulty in producing desired shades and a porcelain free from white edges. Experience only will show the worker how each grade of porcelain should be fired in order to derive the best results. After the furnace door has been closed, one of the most difficult problems of porcelain work is presented to the worker, *i. e.,* How shall I know when the porcelain is properly glazed? The solution of this problem is by no means as difficult as some men would have us believe, neither is it so easy that it can be taught by cold type. In the

Recognition of Glaze

first place, every worker who expects to fire porcelain must learn to recognize the glaze upon its surface according to his own individual idea of what that glaze should be. There is a wide difference of opinion relative to the amount of glaze which should appear in an artificial tooth, a crown, or an inlay. The degree of glaze which one individual would call perfect or desirable would be recognized by another individual as "short of glaze," or by another as "overglaze," so each individual must fix in his own mind his idea of a proper glaze.

To recognize the glaze upon a piece of cold porcelain held in the hand, where it can be turned about at will and viewed in different positions, is one thing, and to recognize this same glaze when the piece is hot is quite another thing, but this recognition is easily acquired with practice.

In the firing of some low-fusing porcelains, like the Jenkins porcelain enamel and Ash's low-fusing, the muffle can remain open and the process of glazing can be watched throughout. Block bodies and high-fusing porcelains require considerably higher temperatures to glaze them, and the glow produced by the heat upon the porcelain and its surroundings will not permit of constant watching, therefore some means must be devised for determining when the glazing of the porcelain takes place. Various methods and devices have been suggested for determining the time when a porcelain product should be removed from the furnace; some of these will be detailed as follows. The method generally pursued depends upon the worker's familiarity with the appearance of the "fire" and the time (by watch) which a given porcelain will require. For example: A Revelation Oil Furnace is being used to fire an artificial denture made of a block body. The temperature of the muffle is raised to a point which the worker judges with his eye to be right for the glazing of the particular porcelain in use. This judgment of temperature by the eye can be relied upon as being approximately correct providing the worker has had long experience. When the proper working temperature is thus obtained, the denture, which should be on a fire-clay slab, is placed in front of the muffle and allowed to remain until all moisture has been driven out and the porcelain be-

Methods for Determining Glaze

gins to warm up. When the preliminary heating has taken place, the denture should be pushed back in the muffle, the door closed, and the case timed.

Time and Eye

Timing the firing is necessarily a matter of experience: it is subject to the judgment of the worker. He knows the "fire," knows the porcelain, and after closing the muffle door he relies first upon his watch and finally upon his eye.

If experience has taught him that three minutes is required to glaze the porcelain, he allows three minutes to elapse, opens the door of the muffle, withdraws the case, looks at it, and if glazed he removes it to the annealing oven. If not properly glazed, the case is pushed back in the muffle and given a longer fire. In cold type the above method of firing porcelain appears very crude, and it is at the best uncertain, although it is thoroughly practical, and when pursued by experienced workers the results are satisfactory. When the supply of electric current is uniform, an electric furnace can be employed to glaze porcelain by the timing method with some degree of certainty. The worker quickly learns by experiment that when the lever of the rheostat is upon a given contact, it requires a definite length of time to properly glaze a given porcelain.

Porcelain Cones

Another method of glazing the block bodies and high-fusing porcelains depends upon "test pieces" placed alongside of the object which is being fired. A cone of porcelain (Fig. 99), for example, is made of the same material as the denture or crown. This cone is dried out and heated just the same as the piece which is being made; both are then placed in the muffle and the door closed. As the firing progresses, the door of the furnace can be opened and the point of the cone observed by the eye. When the

point assumes an outline like that shown in Fig. 100, the glazing is complete; but if there be a doubt in the mind of the worker, he can remove the cone from

Fig. 99

Fig. 100

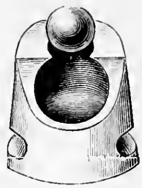
the furnace and examine it in daylight. The glaze on the cone will be practically the same as that on the object being fired.

Gold and Time Another method, and one which can be followed with more or less success, depends upon the melting of pure gold as a guide. A small quantity of foil gold is pinched with the fingers to form a cone or pyramid. This is placed in the muffle on a piece of fire clay alongside of the work and watched until it melts or assumes a pellet form. After the gold melts, a given length of time by the watch is allowed to elapse before the porcelain work is removed from the furnace.

The particular length of time required to glaze a given porcelain after the gold melts must, of course, be learned by experiment before this method of determining the glaze can be depended upon. The time required will vary in the different furnaces. A porcelain which requires one minute after gold in one furnace may require only thirty seconds in another and perhaps a minute and thirty seconds in another furnace; so, as before stated, if this method of firing is to be pursued, the worker must do some experimenting with each grade of porcelain and each furnace before making a practical application. Another

practical method of determining the time when a piece of porcelain work is properly glazed is by the use of the little pyrometer (Fig. 101), devised by Dr. D. O. M. Le Cron, St. Louis.

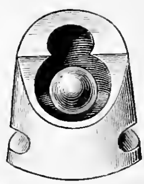
Fig. 101



Pyrometer Metal This pyrometer consists of a fireproof receptacle and a metal pellet or pellets. Different pellets are made of alloys having different melting points corresponding to the glazing points of different porcelain compounds.

Suppose a worker is desirous of firing a crown made of The S. S. White Dental Mfg. Co.'s High-Fusing Porcelain: He selects the pellet the melting point of which corresponds with the glazing point of

Fig. 102



the porcelain mentioned, places it on the top of the fireproof cup, and then places the crown and pyrometer side by side in the muffle of the furnace. As the glazing point of the porcelain is approached the metal pellet softens and elongates until it drops into the bottom of the cup. (Fig. 102.) When this occurs, the porcelain crown is glazed, and the heat can be diminished or the crown removed from the furnace according to the method of cooling pursued by the worker.

About the only objection that can be raised against this way of firing is that of having to look into the glow of the heat, but this objection is theoretical rather than practical. The simplicity and cost of the device and the many advantages derived from its use more than offset any minor objections like the one mentioned. When the pellet melts, cut off the heat or remove the piece from the muffle. That is the method of solving the much-mooted question of firing dental porcelains.

Pyrometers Various kinds of pyrometers have for many years been employed to determine the temperature in places not visible to the eye.

The simplest form of these is the Segar pyrometer cones, which are made after various formulas capable of recording temperatures ranging from that necessary to fuse glass up to that required to melt platinum and "to determine the fireproofness of clay and other like material."

Practical dental application of the principle involved by the Segar cone has been previously described. Pyrometer metal has for a long time been used in the potter's industry. These metals or alloys, like the Segar cones, are made after different formulas capable of recording wide ranges of temperatures. A little strip of the pyrometer metal is placed alongside of the porcelains to be fired, and when the metal assumes the form of a pellet the proper temperature has been obtained. Dr. Le Cron's pyrometer, previously described, is a practical dental application of the pyrometer metal, or, as it is sometimes called, Princeps alloy. Thermo-electric indicating pyrometers of recognized merit are now obtainable, and these can be relied upon to give practical results in the firing of all dental porcelains.

CHAPTER XI.

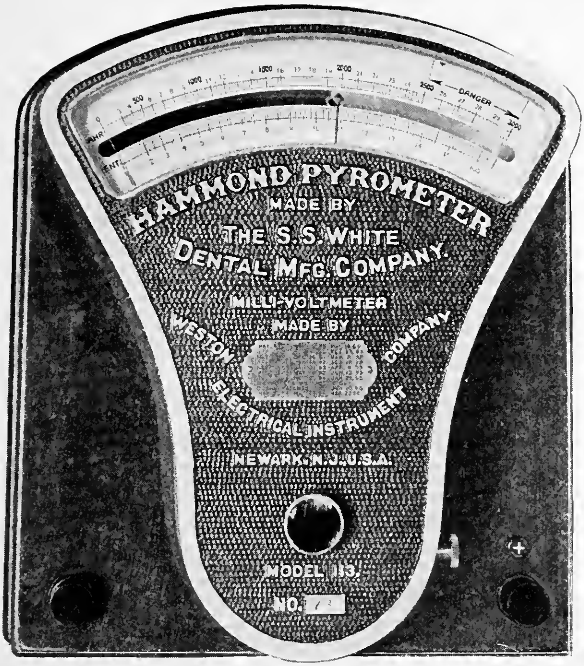
SUGGESTIONS FOR USING THERMO-ELECTRIC PYROMETERS

As stated in the closing words of the last chapter, pyrometers of recognized merit are now obtainable, and they can be depended upon to give practical results in the firing of dental porcelains. This statement is true, but it should not be accepted to mean that these pyrometers will indicate the glazing point of a given porcelain in the same sense as a clock indicates the flight of time. That is, something more than a simple watching of the pyrometer indicator is necessary to determine the proper glaze on an inlay, crown, denture, or bridge.

The thermo-electric pyrometer is a scientific instrument devised for the purpose of determining definite methods of producing desired results, therefore, it must be used scientifically if it is to be used effectively. Before attempting to use the thermo-electric pyrometer it must be thoroughly understood by the operator that the proper glazing of all dental porcelains is dependent upon both time and temperature. Remember that it cannot arbitrarily and truthfully be stated that a given grade of porcelain fuses or takes the glaze at a given temperature, but it may be truthfully stated that a given porcelain can be fused or glazed if subjected to a given temperature for a given length of time. The dentist who

purchases and uses a pyrometer with a full understanding of the above facts will conserve time and energy and will feel amply repaid for the expenditure of money necessary to place a pyrometer at his service.

FIG. 103.

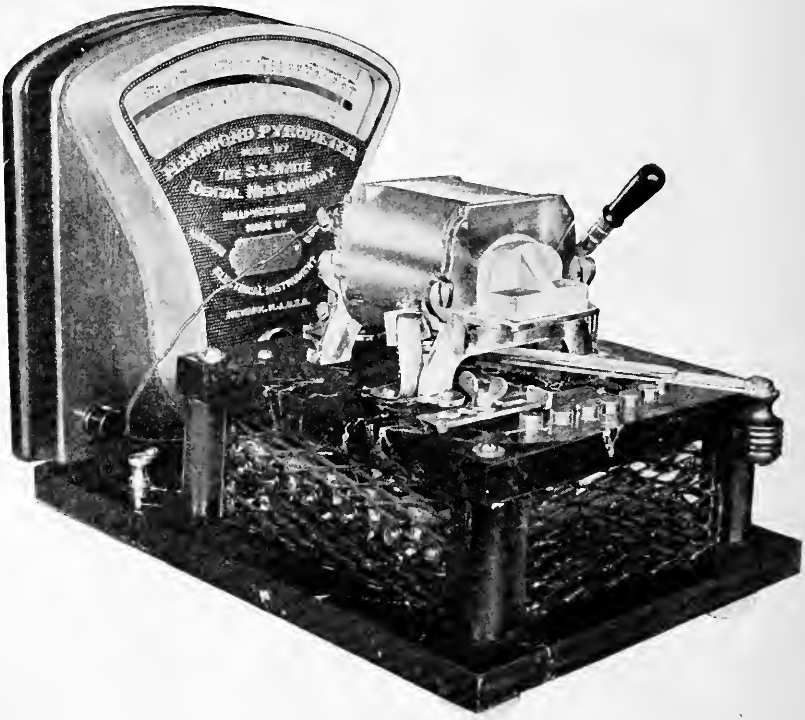


Thermo-Electric Pyrometers as now manufactured for use by the dentist are attached to the furnace in two ways.

In one form the thermo-couple is attached permanently to the rear of the muffle, and in the other it is attached permanently to the door of the muffle,

and is therefore removed from the heat area every time the muffle door is open, or removed. Both forms of attachment have their advocates among porcelain workers. It is, therefore, advisable to

Fig. 104.



study the conditions under which the furnace and pyrometer are to be used, and then be governed in the selection of an outfit accordingly.

Figure 104 shows the attachment of the pyrometer to the rear of the muffle.

Figures 105 and 106 show the attachment of Pyrometer to the front of the muffle through the door.

Fig. 105.

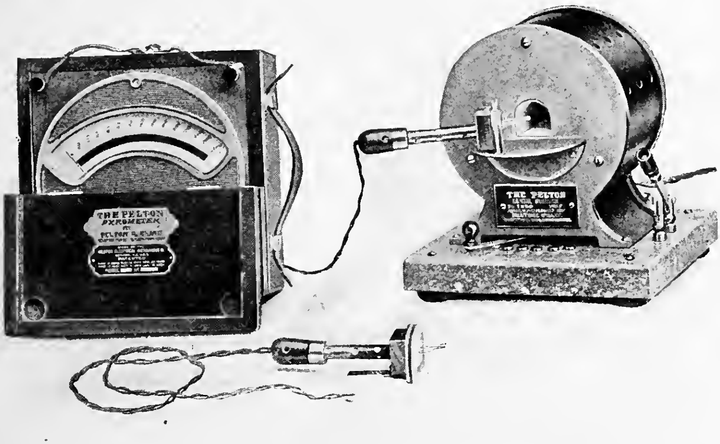
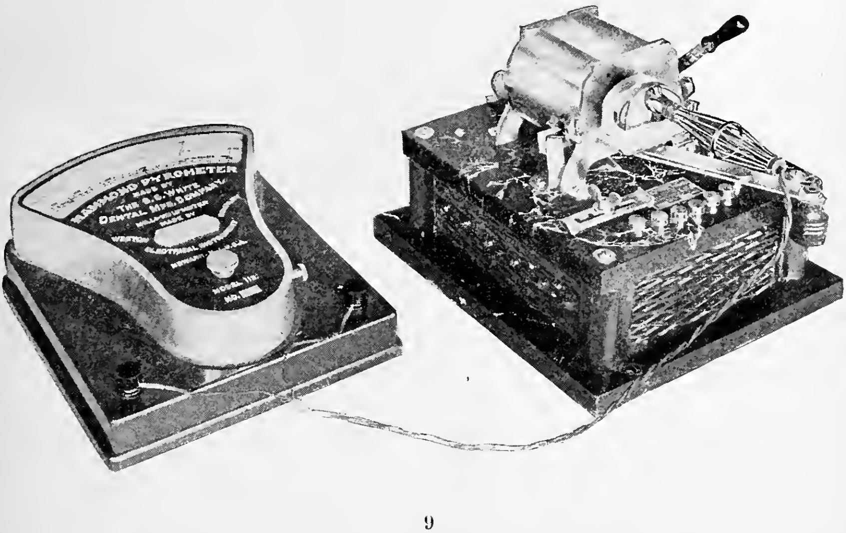


Fig. 106.



Directions Impractical If all pyrometers and all electric furnaces were manufactured as exact duplicates and the electric current was always and at all places uniform, and if all individuals had the same opinion on the subject of glaze, then it would be possible to give definite directions for using pyrometer and furnace, but such is not the case. Pyrometers differ, electric furnaces are by no means uniform, the electric current is subject to constant changes and the opinions of dentists differ, therefore, suggestions rather than directions will be here given for the use of pyrometer and furnace. By offering suggestions rather than directions the pyrometer is rendered applicable to the use of all, notwithstanding the lack of uniformity in the manufactured articles and the varying opinions of different individuals.

Testing the Muffle Each outfit (pyrometer and furnace muffle) should be tested by the dentist for the purpose of ascertaining the temperature which can be obtained in his particular muffle with the control lever of the rheostat on the different contacts. For example: Place the control lever on the first contact of the rheostat and allow it to remain there until the indicator on the pyrometer remains practically stationary. The figure in degrees, Fahrenheit or Centigrade, thus recorded, shows the temperature which can be obtained by operating with the lever on the first contact. Continue the test by recording the temperature obtainable on the second contact, the third, and so on until 2500° F. has been recorded. Not all furnaces will produce such a temperature, but with those that do it is advisable to keep the temperature at or lower than this figure. This caution is given because practical experience has shown that it is inadvisable to run any of the present type of electric

furnaces much beyond 2500° F. After an experiment of this kind the capability of the muffle becomes a known quantity, and a further test, that of glazing the porcelain, should be made.

Testing the Porcelain If the porcelain under test belongs to the high-fusing class the control lever of the rheostat should be placed on the lowest contact which will produce a temperature of at least 2100° F. When this temperature has been obtained, open the muffle door, throw the control lever back to the first contact and place the porcelain under test in front of the muffle to dry out. When the temperature drops to say 1900° F. or lower, place the porcelain in the muffle and, if possible, directly under the thermo-couple. If the piece to be fused is too large to go under the thermo-couple, place it as near the couple as is practicable. Throw the control lever on the fusing contact (the lowest contact which gives 2100° F.), and when the pyrometer registers 1900° F. close the door of the muffle and watch the indicator on the pyrometer. When 2100° F. is recorded, throw the control lever back on the first contact, open the muffle door and remove the porcelain. If the contact which affords 2100° F. does not glaze the porcelain, try the next contact which will give a higher temperature, and so on until the proper contact and temperature is ascertained. When the right contact and right temperature have been thus determined for correctly glazing a given porcelain, the same procedure will indefinitely duplicate results unless the voltage of the electric current is continually changing. To make this method of using the pyrometer plainer, take as an illustration the glazing of two popular porcelains, viz., The S. S. White Dental Manufacturing Company's High-Fusing

Porcelain and C. Ash & Sons High-Fusing Mineral Body, using a Hammond Pyrometer and Hammond Furnace when making the experiment.

An Example The fusing temperature of The S. S. White Dental Manufacturing Company's High-Fusing Porcelain is about 2360° F. The degree of glaze which suits some individuals may require 2340° or 2360°, but whatever temperature is found to give the desired results that is the one to work to. 2300° F. is used in this suggestion merely as an illustration; therefore, test the muffle to determine the lowest contact which will produce 2300° F. The contact necessary to produce this temperature may be the fifth, the fourth or even the third, depending on the current voltage and the muffle wiring, but every time the lever is placed on that contact thereafter a temperature of about 2300° F. will be indicated by the pyrometer. Having found the contact that gives the proper temperature, it establishes a fixed point to which to work. The details of procedure would be as follows: Make several test-pieces of the porcelain (see Fig. 107), and place

FIG. 107.

them on top of the furnace to dry out. Place the control lever on the lowest contact which records 2300° F. or thereabouts. When dry, place one of the test pieces on a fire-clay slide, throw back the lever to the first contact, open the door of the muffle and place the test piece in front of the muffle. Pay no attention

to the piece, but observe when the pyrometer indicates 1900° F. or slightly below. (Some muffles are so well wound that a high temperature is developed with the lever on the first contact, making it impossible to get down to 1900° F. on this contact. If this is the case with the muffle under test, break the current by opening the knife-switch.) Place the porcelain testpiece in the muffle and as near the thermocouple as is practicable. Throw the lever of the rheostat on the contact which records 2300° F. Close the door, and when the indicator registers 2300° F., open the muffle and remove the porcelain. As before stated, while 2300° F. is mentioned as the degree which indicates the proper glaze, it is not to be considered arbitrary, for the reason that several degrees more or less may give the degree of glaze which is preferred by different individuals.

Another Example C. Ash & Sons High-Fusing Mineral Body glazes in a temperature of approximately 1900° F., therefore, the method of glazing this porcelain can be outlined as follows: Place the control lever of the rheostat on the lowest contact which will record 1900° F. After heating the muffle to this temperature, drop the temperature to say 1500° F. or thereabouts (this can be accomplished by either using a lower contact or by breaking the current.) Place the porcelain testpiece in the muffle and under, or as near as possible to, the thermo-couple. Throw the lever of the rheostat on the contact which records 1900° F. When 1500° F. is recorded, close the door of the muffle, and when the pyrometer registers 1900° F., open the door and remove the porcelain.

It must not be understood that the method just suggested is the only one which can be depended upon to give satisfactory results in the glazing of

porcelain, for such is not the case. There are several other methods, among which can be mentioned the following: The method of ascertaining by experiment just what temperature and what time is required to glaze a given porcelain, and then pursue the following detail: Keep the temperature in the muffle at the desired figure by shifting the lever of the rheostat; place the porcelain to be glazed in the muffle—this will cause the temperature to drop many degrees, but it is soon brought back to the desired degree—and allow a given amount of time to elapse, then open the door of the muffle and remove the work.

Another Method

For example: To glaze a crown made of The S. S. White Dental Manufacturing Company's High-Fusing Porcelain, raise the temperature in the muffle to at least 2300° F., place the crown (which should be free from all moisture) in the muffle, close the door, watch the pyrometer, and when the indicator registers 2300° F., take an account of the time, keeping the pyrometer at 2300° F., and allow one and one-half minutes to pass, after which immediately remove the crown. Different bulks of porcelain will require different lengths of time, but this variation in time is readily ascertained by experiment.

First Method Preferable

Of the two methods above suggested for the use of the pyrometer and furnace, the first is preferable—first, because it caters to the peculiar characteristics of porcelain, and second, it is better adapted to the practical working methods of the dentist. Generally speaking, all dental porcelains should be gradually heated from the room-temperature to the temperature required to produce the glaze; in fact, some must be treated in this way in order to insure form and color. The method first

suggested is based upon this observation, and it will be found that if porcelain is treated in this way, better results will be secured than in the pursuance of a method which subjects the cold porcelain immediately to its glazing temperature.

Aside from the fact that dental porcelains should be gradually heated to their glazing temperature, the method which provides for such treatment facilitates the work of the dentist by eliminating eye-strain and nervous tension, and it insures drying out without the loss of any time.

Conclusion Use the thermo-electric pyrometer simply as a device for duplicating results in the firing of dental porcelains.

The method of using is a matter to be decided upon by the individual operator. As stated in the foregoing pages, absolute directions for the use of this instrument are of little practical value; and, furthermore, let it be thoroughly understood, that the methods outlined are only suggestions.

Criticism of Pyrometers Any device or instrument which may be used to determine the glaze upon porcelain will be subject to adverse criticism, unless it be used with intelligence. It will not do for any one individual to arbitrarily say that the melting point of a given alloy will produce a glaze upon a given porcelain which will be satisfactory to every worker; neither will it do to say that a definite number of degrees of temperature will produce a glaze acceptable to every one. Individual workers will have their own peculiar ideas relative to the amount of glaze which a porcelain should receive, and they will have to establish temperatures by the aid of devices or instruments which will meet their own requirements. In the case of the Le Cron pyrometer, the manufac-

turer might supply an alloy the melting point of which would agree with his (the manufacturer's) idea of a proper glazing point, but a worker desiring less glaze or more glaze upon the same porcelain would not be satisfied to accept the alloy of the manufacturer as his (the worker's) guide. This same statement is true regarding the use of a pyrometer which records definite degrees of temperature. Two thousand degrees Fahrenheit may be the figure arbitrarily stated by anyone to be the correct glazing temperature of a given porcelain, but this statement does not necessarily have to be accepted by every worker as being correct. Because an instrument viewed in connection with printed statements may be subject to the criticism just cited, condemnation of the instrument should not follow. The device or instrument may be perfectly satisfactory, but the judgment of the worker may be defective. In the case of the LeCron device the worker can lower or raise the melting point of the alloy to meet with his own ideas of glaze, or in the case of a temperature-recording instrument he will experiment and determine the temperature which will produce the correct glaze as he views it. The consideration of time in connection with temperature is highly important when operating a temperature-recording pyrometer. Experiments should be conducted by each worker with the object in view of establishing the temperature and time required to derive the best results from the porcelain compound in use. Is it best to subject this porcelain to a high temperature for a short time, or is it best to subject it to a low temperature for a long time? This question should be asked and answered by the worker as he attempts to use the various compounds.